Taxometric Analysis of Hallucinations:

Are Hallucinatory Experiences Dimensional or Taxonic?

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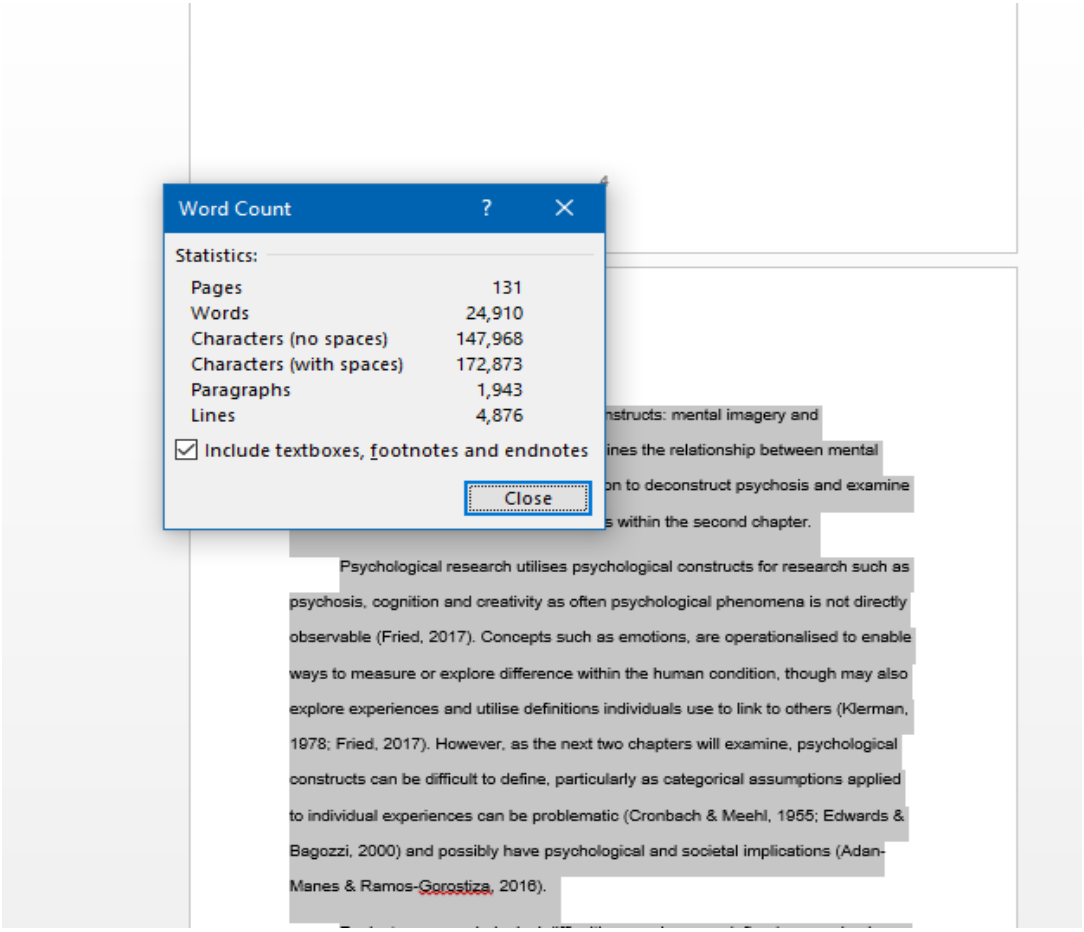
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Introduction: Thesis overview

This thesis examines two psychological constructs: mental imagery and hallucinations where the first chapter examines the relationship between mental imagery and hallucinations before moving on to deconstruct psychosis and examine hallucinations through a taxometric analysis within the second chapter.

Psychological research utilises psychological constructs for research such as psychosis, cognition and creativity as often psychological phenomena is not directly observable (Fried, 2017). Concepts such as emotions, are operationalised to enable ways to measure or explore difference within the human condition, though may also explore experiences and utilise definitions individuals use to link to others (Klerman, 1978; Fried, 2017). However, as the next two chapters will examine, psychological constructs can be difficult to define, particularly as categorical assumptions applied to individual experiences can be problematic (Cronbach & Meehl, 1955; Edwards & Bagozzi, 2000) and possibly have psychological and societal implications (Adan-Manes & Ramos-Gorostiza, 2016).

For instance, psychological difficulties may become defined as psychosis; an umbrella term of a variety of experiences such as hallucinations, delusions, thought disorder (Lee et al., 2016; van Os & Reininghaus, 2016; Yung & Lin, 2016). Problematically, these experiences are often linked to potentially controversial psychiatric classification systems, where overlaps between diagnoses (like schizophrenia and schizoaffective disorder; Burgy, 2008; Preti et al., 2014) impact on construct validity (Adan-Manes & Ramos-Gorostiza, 2014; Adan-Manes & Ramos-Gorostiza, 2016; Linscott & van Os, 2010; Zachar, 2002). Moreover, psychosis as a label can be stigmatising (Brohan, Eigie, Sartorius, & Thornicroft, 2010; Hori,

Richards, Kawamoto, & Kunugi, 2011; Lien, et al., 2015) and does not capture the breadth of the experiences for people (Lien et al., 2015; McGrath, et al., 2015; Peters et al., 2016; Unterrassner et al., 2017).

Underpinning psychiatric diagnoses are specific experiences, like hallucinations, which within themselves are psychological constructs. However, individual experiences of hallucinations will vary; some will experience significant distress from hallucinatory experiences, whereas others will not (Johns, 2005; Larøi, 2012; Maijer, Begemann, Palmen, Leucht, & Sommer, 2018). Moreover, hallucinations can be linked to different sensory modalities, such as auditory, visual or tactile hallucinations (Larøi et al., 2004; Larøi & Woodward, 2007). Consequently, chapter two will explore the potential differences in these, through exploring whether hallucinations are a dimensional or categorical/ taxonic concept.

In a similar fashion, controversy also lies within concepts of linking psychological constructs together. For instance, a multitude of research examines potential links between psychopathology and mental imagery (Holmes & Mathews, 2010; Holmes, Iyadurai, Jacob, & Hales, 2015; Pearson, Naselaris, Holmes, & Kosslyn, 2015; Weßlau & Steil, 2014). Studies have also argued specific diagnoses may be associated with either enhanced mental imagery such as more vivid imagery or diminished mental imagery (Clark, James, Iyadurai, & Holmes, 2015; Karatzias, Power, Brown & McGoldrick, 2009; Maxwell, Lynn, & Lilienfeld, 2017; Morina, Deeprose, Pusowski, Schmid, & Holmes, 2011; O'Donnell, Di Simplicio, Brown, Holmes, & Heyes, 2017).

Interestingly, this research has also examined different forms of mental imagery, such as intrusive, positive or negative imagery. However, there can be

difficulties in defining what mental imagery is, particularly in contrast to hallucinatory experiences (Nanay, 2016). Debates exist around whether mental imagery may be a form of hallucinatory experiences, or may play a role in acting as a predisposition to hallucinations (Thomas, 2014). However, there is no clarity in the literature whether this factor plays a role, suggesting a systematic review may be necessary to explore hallucinations and mental imagery.

Mental imagery can have a multitude of definitions but for the purposes of this paper, the focus will be on Richardson's (1969) definition. Richardson (1969) defined mental imagery as involving subjective and objective processes, where individuals develop or form mental representations, which may fall within particular sensory modalities, such as tactile, olfactory, visual and auditory. Moreover, mental imagery may rely on memory processes, particularly in forming imagery based on previous experiences and/or forming mental images based on new experiences (Frank, Land, Popp, & Schack, 2014; Laeng, Bloem, D'Ascenzo, & Tommasi, 2014).

Mental imagery is also believed to be beyond perception and visualisation; where visualisation is only part of the process in mental imagery (Nanay, 2016). For instance, mental imagery may enable individuals to consider future events or relive previous past events, potentially induced in the absence of a perceptual experience (Kosslyn, Ganis, & Thompson, 2001). Moreover, mental imagery may be triggered by different sense modalities, for instance olfactory imagery may be triggered by an auditory stimulus (Nanay, 2017; Pearson et al., 2015), and does not necessarily have to be conscious, as shown in neural research (Zeman et al., 2007, 2010; Zeman, Dewar, & Della Sala, 2015) .

Therefore, mental imagery lies within different theoretical frameworks, such as philosophy, neuroscience, and cognitive theories (Nanay, 2017; Pearson et al., 2015), where debates are around how mental imagery is formed, interpreted and influences individuals' experiences, particularly if potentially maintaining psychological difficulties. Consequently, mental imagery may have clinical implications, such as within psychological therapies for hallucinations.

Therefore chapter one will utilise a general concept of mental imagery, exploring the ways this is measured in attempts to establish the main theoretical basis within research, whilst systematically reviewing the literature in its potential associations with hallucinations. This will also include discussing the implications of the review's findings within the context of psychological therapies and understanding hallucinations. Following on from this, chapter two will address hallucinations as a concept within psychiatry and other professions. Chapter two will detail an empirical study that used taxometric analysis on secondary data from clinical and non-clinical samples to explore whether hallucinations are taxonic (categorical and distinctive) or dimensional.

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Chapter One: Systematic review

Mental Imagery and Hallucinations[1]

[1]Article prepared for submission to British Journal of Social and Clinical Psychology. Appendices A-F for thesis submission only. Not to be submitted to target journal.

Abstract

Introduction

Mental imagery has been implicated in pathological processes such as hallucinations. Indeed, addressing mental imagery has also been highlighted as a potential therapeutic process in forms of psychotherapy. However, there is limited clarity around the nature of associations between hallucinations and mental imagery.

Aims

Potential associations between mental imagery and hallucinations were examined, and the methodological quality of papers exploring these associations was conducted using the Quality Assessment of Diverse Designs Tool (QATSDD).

Methods

Searches were based on the terms “hallucinations/voice hearing AND mental image/vivid imagery”. Inclusion criteria; adult participants with hallucinatory experiences, mental imagery measures, and exploration of associations between hallucinations and mental imagery. Exclusion criteria; full text unavailable in the English language, and no exploration of relationships between mental imagery and hallucinations.

Results

A total of 15 studies met criteria for the review; only seven were quality assessed to ratings above 50% on the QATSDD. This review found mixed findings, though the potential indication of significantly higher mental imagery in hallucinations.

Discussion

There are potential links between hallucinations and vividness of mental imagery. Further research may explore specific types of mental imagery (e.g. vividness, intrusiveness and valence of mental imagery) in relation to different types of hallucinations (e.g. auditory and visual).

Key words: Mental imagery, systematic review, hallucinations, vivid imagery.

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1. Introduction

1.1. Background

Mental imagery has been defined as "using all the senses to recreate or create an experience in the mind" (Cumming and Williams, 2014). Mental imagery has been implicated in psychological therapies, sports and cognitive processes (Ascone, Sundag, Schlier, & Lincoln, 2017; Gregg & Hall, 2018; Leaviss & Uttley, 2015). Indeed, mental imagery has been highlighted as a key focus for psychological therapy (Pearson, Naselaris, Holmes, & Kosslyn, 2015). For example, imagery has been used within Compassion-Focused Therapies (CFT), where positive imagery is formed as a coping strategy for distressing experiences (Gilbert, 2014). However, individuals' capacity to utilise mental imagery varies, and can have repercussions for distorted self-image perceptions (such as in body dysmorphic disorder; Darling et al., 2015), levels of distress, and creativity (Doop & Park, 2003; Palmiero, Nori, Aloisi, Ferrara, & Piccardi, 2015).

Mental imagery can be defined as sensory representations that are developed without the explicit need for direct external stimulus, potentially relying on memory processes to recall previous information. However, mental imagery has roots within different frameworks, therefore is not just limited to cognitive processes theories (Hebb, 1968; Pearson, Naselaris, Holmes & Kosslyn, 2015; Thomas, 2014). Mental imagery can also be involuntarily triggered, such as when an external situation or event may lead to reactivation of mental imagery (Byrne, Becker, & Burgess, 2007; Nanay, 2015). For instance, traumatic events may lead to intrusive mental imagery being experienced; a potential important focus for psychological therapy (Brewin, Gregory, Lipton, & Burgess, 2010; Brewin & Burgess, 2014; Holmes & Mathews, 2010).

In terms of specific cognitive processes, research has explored the role that visuospatial memory plays in mental imagery, particularly around an individual's ability to hold images in mind in order to solve visual puzzles (Ahsen, 2003; Yan et al., 2013). This links to computational theories of mental imagery, where it is argued behavioural tasks can assess the processes within mental imagery; this includes how mental imagery is experienced, how mental imagery is generated, how these images are maintained, perceived and transformed within the mind (Kosslyn, Thompson, & Ganis, 2006).

Mental imagery is also argued to involve reactivation of neural activity patterns from perception experiences (Albright, 2012; Buchsbaum et al., 2012), meaning there may be a reliance on working memory. Within this theory, eye movements stimulate brain activity, inducing reorganisation of the temporary images formed from perceptive experiences. This leads on to the formation of a full image, allowing reduction of interference between different parts of the image. Therefore, vividness and detail of the mental imagery are dependent on the order of neural activity patterns during the reactivation phase, with lower-order visual regions eliciting greater subjective vividness and higher-order visual regions producing less vividness (Hebb 1968; Bone et al., 2018).

Consequently, mental imagery can impact positively and negatively on emotional wellbeing. Negative imagery (particularly that of an intrusive nature) can be linked to traumatic memories and experiences, potentially playing a role in how trauma experiences are maintained (Brewin et al., 2010; Brewin & Burgess, 2014; Holmes & Mathews, 2010). Therapies like Eye Movement Desensitisation Reprocessing (EMDR), and Mindfulness Cognitive Therapy (MCT) may reduce the vividness of emotionality of negative memories, due to placing higher loads on

working memory capacity (Hout, Muris, Salemink, & Kindt, 2001). It is argued this may disrupt vividness of mental imagery (Hout et al., 2001). As such, mental imagery can be an important intervention target in psychological therapies (Ng, Di Simplicio, & Holmes, 2016). Moreover, there are arguments that mental imagery can underlie the effectiveness of therapies such as Cognitive Behavioural Therapy (CBT; Holmes, Arntz, & Smucher, 2007) and Schema Therapy (ST; Giesen-Bloo et al., 2006).

Mental imagery has been linked to psychiatric diagnoses, where it has been argued predispositions to using mental imagery can precede, and/or maintain, the likelihood of developing psychological difficulties (Coughtrey, Shafran, & Rachman, 2015; O'Donnell, Di Simplicio, Brown, Holmes & Heyes, 2017; Jelinek et al., 2015). For example, mental imagery has been shown to play a central role in mental disorders such as Major Depressive Disorder (MDD), General Anxiety Disorder (GAD), specific phobias, social anxiety disorder, Obsessive-Compulsive Disorder (OCD) and paranoia (Brewin, Gregory, Lipton, & Burgess, 2010; Bullock, Newman-Taylor, & Stopa, 2016; Holmes & Mathews, 2010). Within depression and bipolar disorder, mental imagery may also be linked to visualisations of past failures, trauma and future events like suicidal acts (Gracie et al, 2007; Kuyken & Brewin, 1994; Holmes, Crane, Fennell, & Williams, 2007).

Moreover, mental imagery can be argued to lie on a continuum which leads to hallucinatory experiences (Benson & Park, 2013; Klein & Moritz, 2014). Morrison et al. (2002) found 74% of individuals who had received a diagnosis of schizophrenia experienced mental images associated with their hallucinations or delusions. These appeared to be recurrent and linked to memories, specific emotions and paranoid beliefs. Additionally, 73% of individuals who experienced persecutory delusions,

reported distressing imagery linked to their paranoia experiences (Schulze, Freeman, Green, & Kuipers, 2013).

Distinct differences have been drawn between mental imagery and hallucinations, in terms of cognitive processes such as reality discrimination (Böcker et al., 2000; Moseley, Smailes, & Ellison, 2016; Smailes, Meins, & Fernyhough, 2015), how images are perceived, and how beliefs about the images may influence interpretation of mental imagery (Howe & Carter, 2016; Morrison, 2001). For instance, eye movements occur during mental imagery, and set aspects can be focused on with some degree of controllability within mental imagery, even if involuntarily occurring (Laeng, Bloem, d'Ascenzo & Tommasi, 2014; Richardson, 1969). However, hallucinations may not involve eye movements, and instead involve imagery that is less based on reality/typical perception experiences (Allen, 2015; Nanay, 2016). Eye movements have also been found to disrupt spatial but not visual imagery, when focusing on details within a mental image. This means there may be other factors in mental imagery formation (de Vito, Buonocore, Bonnefon, & Sala, 2014).

It has been proposed that hallucinations may arise from internally generated mental imagery that has been erroneously attributed to external sources, also termed external misattribution bias. External misattribution refers to interpreting internal experiences as occurring in the external perceptual experience, meaning internal thoughts may become perceived as external voices (Morrison, 2001). Therefore, individuals may interpret mental imagery as occurring within reality, due to difficulties in discriminating between external perceptual experiences and internal mental events (Jones & Fernyhough, 2007; Martin et al., 2017). Consequently, the vividness of imagery may be a factor within external misattribution bias, as higher

vividness of imagery may be to the extent that there are difficulties distinguishing between mental imagery and actual perceptual imagery (Böcker, Hijman, Kahn, & de Haan, 2000). Moreover, there are arguments for higher vividness of imagery been linked to hallucinatory experiences and reality discrimination (Matthews, Collins, Thakkar, & Park, 2014; Pearson et al., 2015).

Reality discrimination refers to how individuals distinguish between internal and external sources of information, which may be filtered through unconsciously set criteria that can be influenced by context effects (such as sensory deprivation) and/or information processing bias (Bentall, 2013). Therefore individuals who have higher vividness of imagery and a tendency to have external misattribution bias may be more likely to struggle with reality discrimination, leading to potential hallucinatory experiences based on mental imagery (Böcker et al., 2000).

Underpinning these theories of mental imagery and hallucinations lies research that may vary in quality, meaning critical appraisal of the studies quality can prove useful when interpreting research findings. Tools have been developed to aid assessment, termed risk assessment of biases, allowing researchers to assess multiple papers on set criteria that will examine potential biases within the research. This can be difficult when reviewing papers of different/opposing research designs (for instance quantitative, qualitative or mixed-methods), as assessment criteria may be dependent on the design, particularly in terms of data analysis critique (Booth, Sutton, & Papaioannou, 2013).

One such tool, Quality Assessment Tool for Studies with Diverse Designs (QATSDD; Sirriyeh, Lawton, Gardner, & Armitage, 2012) was developed to address this limitation, using broad criteria to assess different aspects of methodological design and analysis for potential bias. QATSDD also enables considerations of

validity and reliability in both quantitative and qualitative research. Although the QATSDD is not without its limitations, this tool can be beneficial for systematic reviews that do not solely focus on randomised controlled trials and incorporate a range of designs.

1.2. Aims

This review aimed to explore existing literature that has investigated associations between mental imagery and hallucinations. Potential links between different forms of hallucinations (including visual, auditory and other types in clinical and non-clinical populations) and properties of mental imagery (including vividness of mental imagery, intrusive imagery, and valence imagery) are explored.

Examination of the ways in which mental imagery has been measured within the context of hallucinations was also addressed in this review. As such, the review sought to include studies that had used psychometric assessments or behavioural tasks (as mentioned in a review by Pearson et al., 2013) to measure mental imagery and explore associations with hallucinations.

Specific questions addressed within the review included:

a) Is there an association between mental imagery and hallucinations?

b) How has mental imagery been assessed in studies?

c) What is the methodological quality of papers within mental imagery and hallucinations research?

d) If there are associations between mental imagery and hallucinations, what are the implications within clinical practice for psychological treatment of hallucinations?

2. Method

2.1. Search Strategy

A systematic review protocol was pre-registered on the PROSPERO database (Reference: CRD:42018088611). Papers were identified by following the protocol to search the following databases: Medline, SCOPUS, PsycINFO and Web of Science databases. Databases were searched in March 2018-May 2018 using the terms:

(hallucinat* OR voice hear* OR hear* voices or “positive symptom*”) AND (mental image* OR vivid* image* OR visu* image* OR musical image* OR auditory image* OR creative image* OR intrusive image*)

All duplicates were removed from identified papers, and initial screening of titles and abstracts were carried out by the main researcher (C.F). Any papers not considered eligible based on title or abstract were excluded, and papers with unclear eligibility were included at this stage. Authors were contacted for full texts if these were unavailable, particularly for conference or poster abstracts. Full texts were then screened using inclusion and exclusion criteria as stated in the protocol; those not meeting criteria were excluded. Authors of eligible studies were also contacted for additional data if there was no clear data examining the relationship between mental imagery and hallucinations and were contacted to check for potential further eligible papers (published or unpublished). Hand-searches of the references lists of eligible studies were also conducted to check for further papers potentially missed from the initial searches.

Parallel screening was also undertaken by a second reviewer (AE), randomly selecting 10% of the initial 3389 papers (using random number generator). There

was 100% agreement between reviewers at the end of the parallel screening process.

2.2. Eligibility Criteria

Studies were considered eligible for inclusion if they met the following criteria:

a) Written in the English language,

b) Included adult participants,

c) Examined the relationship between mental imagery and hallucinations,

d) Included non-clinical experiences of hallucinations,

e) Included mental imagery measures,

f) Included self-report measures or clinician-led evaluation of hallucinations.

Studies were excluded if they:

a) Explored brain injuries, neurological/biological hallucinations, musical hallucinations (which often relate to brain injuries or physical disabilities such as deafness),

b) Had no exploration of mental imagery or hallucination within the study,

c) Only focused broadly on psychosis or other specific diagnoses with no specific mention of hallucinations,

d) Had no measures of mental imagery or hallucinations,

e) Involved children (under 16 years)

f) Had full-texts not available in English,

g) Were editorials, narrative reviews or conceptual discussions as these will not include measurements of mental imagery or hallucinations,

h) Were psychoanalytical papers examining the psychotic defence or imagery in context of psychoanalytic frameworks.

2.3. Risk of Bias Assessment

The review used the Quality Assessment Tool for Studies with Diverse Designs tool (QATSDD; Sirriyeh et al., 2012) to assess quality of the studies (see appendices for further details). This tool has been used for studies with experimental data, observational data, quantitative and qualitative data and other diverse designs (Sirriyeh et al., 2012; Fenton, Lauckner, & Gilbert, 2015. The QATSDD enables a percentage mark to be applied to the studies to enable qualitative and quantitative designs to be equally assessed across 16 points (14 for quantitative only designs; 14 for qualitative only designs), allowing for a detailed score to be produced. For each point, a score between 0-3 (0: not mentioned to 3 meeting full criteria/higher quality) is assigned; scores are then totalled for all the applicable points. Risk of bias assessments were carried out by the main researcher (CF) and a second reviewer (AE). Initial agreement was 68.75%, and resolved to 100% level after discussions and re-reviewing quality assessment analyses.

3. Results

3.1. Study Characteristics

Studies identified at each stage are summarised in the PRISMA diagram detailed in Figure 1. A total of 15 papers met the inclusion criteria, involving a total of 1085 participants (median: 60; mean: 67.8). One paper involved two studies; one as a replication of the first study with an additional measure. Two different samples (different selection of students from the same pooled sample) were recruited for these respective studies.

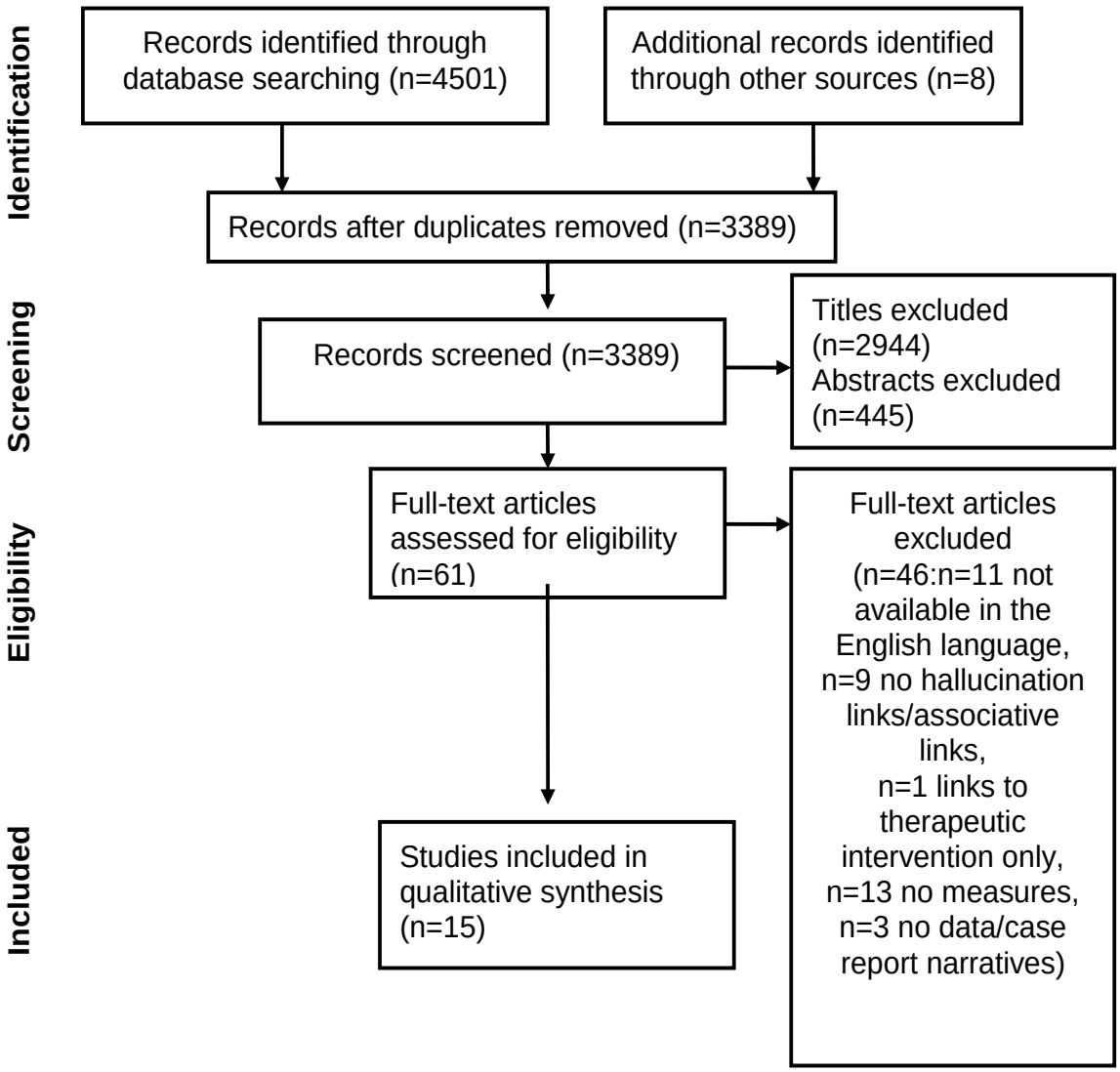

Figure 1. *PRISMA flow diagram*

Study characteristics for the included studies are detailed in Table 1. All studies utilised cross-sectional designs. Studies included clinical samples with diagnoses of schizophrenia, affective disorder and personality disorder. Non-clinical samples primarily involved student participants, with four studies using healthy controls/non-student samples.

Hallucination measures included the Launay-Slade Hallucinations Scale (LSHS; Launay & Slade, 1981; Bentall & Slade, 1985), Verbal Hallucinations Questionnaire (VHQ; Barrett & Etheridge, 1992), Positive and Negative Symptoms Scale (PANSS; Kay, Fizbein & Opfer, 1987), Scale for Assessment of Positive

Symptoms/Negative Symptoms (SAPS; Andreasen, 1984a; SANS; Andreasen, 1984b).

Table 1*: Study characteristics*[2]

Study/ Country	Design	Sample characteristics	Demographics	Hallucination measures	Mental imagery measures
Aleman, Böcker & de Haan (2001), Netherlands	Experiment /cross-sectional	Total=57 (students)	M=12, F=45, mean age= 21.1 (SD 3.5)	LSHS (revised, Bentall & Slade, 1985)	BVS (Richardson, 1969) Sound comparison task: (Mehta, Newcombe, & de Haan, 1992)
Aleman, Nieuwenstein, Böcker & de Haan (2000), Netherlands	Experiment/ cross-sectional	Total=26 (out of 243 students) High LSHS=19 Low LSHS=17	mean age= 22.6 (SD 5.6) M=6, F=13 M=5, F=12	LSHS (revised Bentall & Slade, 1985)	BVS (Richardson, 1969) VVIQ (Marks, 1973) Object imagery (Mehta et al., 1992) Imagery-Perception Interaction (Farah 1989) Letter Imagery (Kosslyn et al., 1988) Musical Imagery (Halpern, 1988)
Aleman, Böcker & de Haan (1999) , Netherlands	Experiment/ cross-sectional:	Total=57 High LSHS=26 Low LSHS=31 (students)	M=20, F=54, mean age=21.2 (SD 1.8)	LSHS (revised Bentall & Slade, 1985)	BVS (Richardson, 1969) Experimental vividness of imagery task (Mehta, Newcombe, & de Haan, 1992)
Aynsworth, Nemat, Collerton & Smailes (2017), UK (experiment 2)	Experiment/ cross-sectional:	HVH=26 LVH=21 (students)	M=5, F=21 mean age 25.53 (SD 10.55;18-54 years) M=4, F=17 mean age 23.52 (SD 9.15; 18-54 years)	LSHS (Morrison, Wells, & Nothard, 2000)	SUIS (Reisberg, Pearson, & Kosslyn, 2003) VVIQ (Marks, 1973) PIT (Stober, 2000, Holmes et al., 2011) Reality monitoring task (Brebion et al., 2008)

[2] Acronyms details are within a key after the table.

Barrett (1993a), USA	Experiment/ cross-sectional	High LSHS=31 Low LSHS=31	M=10, F=21 mean age 19.16 M=12, F=19 mean age 19.87	VHQ (Barrett & Etheridge, 1992)	BVS (Richardson, 1969)
Barrett (1993b), USA	Experiment/ cross-sectional	High LSHS=31 Low LSHS=31	M=8, F=23 mean age 19.48 M=14, F=17 mean age 22.42 (Age: F[1,60] =4.98, p<0.03)	VHQ (Barrett & Etheridge, 1992)	BVS (Richardson, 1969)
Böcker, Hijman, Kahn & de Haan (2000), Netherlands	Experiment/ cross-sectional	H-SZ=13 NH-SZ= 19 Controls=14	M=12, F=1 mean age=33 (SD 9) M=13, F=6 mean age 35 (SD 10) M=11, F=3 mean age=32 (SD 12)	PANSS; Kay, Opler, & Fizbein, 1986)	Just Noticeable Differences (perception test) (de Haan, Heywood, Young, Edelstyn, & Newcombe, 1995) VMI (Mehta, Newcombe, & de Haan 1992) Reality Discrimination (based on category association tasks: Harvey, 1985; Morrison & Haddock 1997)
Brett & Starker (1977), USA	Experiment/ cross-sectional	H-SZ=20 NH-SZ= 20 Controls (medical patients)= 20	mean age=33.0 mean age=34.5 mean age=49.6 All male participants.	None (Used staff reports for diagnosis/ records)	BVS (Betts, 1909; Richardson, 1969) Controllability of Auditory Imagery (Gordon,1950) Imaginal Processes Inventory (Singer & Antrobus, 1966)

David & Cutting (1992), UK	Experiment/ cross-sectional	SZ=46 (29 inpatients, 17 outpatients: 15 VH) AD=22 (12 with D, 10 with BA) Controls =30 (staff)	M=30 F=16 mean age=30.9 (SD 7.6) M=8, F=14 , mean age=37.4 (SD 13.7) M=17, F= 13 mean age=33.1 (SD 6.1) (Significant differences ($p<0.05$).	LSHS (Launay & Slade, 1981): Only administered to controls. DSM-IIIR Present State examination (Wing et al., 1974)	Visual cognition tests: Stimuli used from Snodgrass & Vanderwart (1980) line drawings
Glazer, Mason, King & Brewin (2013), UK	Experiment/ cross-sectional	Students=31 students Non-students=24	M=23, F=32 mean age=24 years (18-52 range) (No significant effects for gender, age, student status)	LSHS-revised (Bentall & Slade, 1985)	Intrusive Imagery Interview (Brewin et al., 2010).
Heilbrun, Blum & Haas (1983), USA	Experiment/ cross-sectional	SZ=24,D=3,PD=3) H =16 (15 diagnosed with SZ), NH=14 (9 diagnosed with SZ)	 M=9, F=7 M=11, F=3 (matched for age and education)	None (Used staff reports for diagnosis/ records)	Preferred imagery task (Norbert, 1971, 1973) Voice location task

Mintz & Alpert, (1972), USA	Experiment/ cross-sectional	20 H-SZ	M=14 F= 6, mean age 28.7 (13 paranoid, 5 chronic, 2 acute)	None (Used staff reports for diagnosis/ records)	Vividness of Auditory Imagery task (Mintz & Alpert, 1972)
		20 NH-SZ	M=12, F=8, mean age 31.4 (6 paranoid, 9 chronic, 3 acute, 2 schizoaffective)		
		20 Control (inpatients)	M=13, F=7, mean age=31.6 (No significant medication effects (p=0.10)		
Oertel, et al., (2009), Germany	Experiment/ cross-sectional	Paranoid SZ=52	M=31, F=18, mean age=38.90 SD 9.93	LSHS (revised) (Bentall & Slade, 1985)	VMI (Sheehan, 1967)
		R=44	M=22, F=22 mean age=41.27 SD 14.92		
		High Schizotypal=24	M=8, F=16 mean age=31.42 SD=11.64		
		Low Schizotypal=24	M=13, F=11 mean age= 32.89 SD 8.46		
Sack et al. (2005), Netherlands	Experiment/ cross-sectional	Paranoid SZ=50	M=31, F=19, mean age 36.4 (SD 9.8; range 19-57)	LSHS (Launay & Slade, 1981) SAPS (Andreasen, 1984)	VMI (Sheehan, 1967) LPS (Leistung-sprüfsystem; Horn 1962)
		Controls=50 (age and gender matched)	M=31, F=19, mean age= 36.4 (SD 9.7; 19-57)		

Starker & Jolin (1984), USA	Experiment/ cross-sectional:	SZ= 70% [49] (25 current auditory hallucinations, 4 with auditory and visual hallucination (46% H [22.54], 54% NH [26.46] Non-SZ=30% sample [21] (Clinical inpatients)	Mean age of all participants= 30.6 (SD 7.2) All participants male	None (Used staff reports for diagnosis/ records)	Thought sampling (Foulkes, Fleisher, & Trupin, 1974; Singer, 1975) Imaginal Processes Inventory (IPI) (Singer & Antrobus, 1966)
van de Ven & Merckelbach (2003), Germany	Experiment/ cross-sectional:	Total=111 (3 excluded/missing items) (Student)	M=23, F=88 Mean age= 20 years (SD 2.18; range 18-31)	LSHS (Launay & Slade, 1981) White Christmas task (Merckelbach & van de Ven, 2001)	Betts QMI (shortened) (Sheehan, 1967)

Key

Characteristics
AD= Affective Disorder
BA= Bipolar Affective Disorder
D=Major Depression
F=Female
H=Hallucinating
HVH= High Visual Hallucinating
LVH= Low Visual Hallucinating
M=Male
NH=Non-Hallucinating
PD= Personality Disorder
R= First Degree Relatives
SZ=Schizophrenia
VH= Visual Hallucinations

Mental Imagery measures
BVS= Betts Vividness of Imagery Scale
IPI= Imaginal Processes Inventory
LPS= Leistung-sprüfsystem
PIT=Prospective imagery task
QMI= Questionnaire of Mental Imagery
SUIS=Spontaneous use of imagery scale
VMI=Vividness of Mental Imagery
VVIQ= Vividness of Visual Imagery Questionnaire

Hallucination Measures
DSM-IIIR= Diagnostic and Statistical Manual of Mental Disorders version three (revised)
LSHS=Launay-Slade Hallucinations Scale
PANSS= Positive and Negative Symptoms Scale
SAPS= Scale for Assessment of Positive Symptoms
VHQ= Verbal Hallucinations Scale

Table 2. details the main findings from the papers. Studies either used clinical and non-clinical (controls) samples (n=4), non-clinical only samples that assessed hallucination proneness (n=7) or clinical only samples (n=4). Clinical only samples involved clinical controls (for instance medical or clinical samples not experiencing hallucinations) to compare with participants experiencing hallucinations.

Table 2. *Findings from studies using clinical samples*

Clinical samples			
Study	**Clinical/ non-clinical**	**Primary findings**	**Positive/negative or neutral relationship (hallucinations and mental imagery correlations/group differences)[3]**
Brett & Starker (1977)	Clinical: 60 (20 medical controls)	Mean scores for vividness was similar across the groups, with emotional interpersonal items scoring the lowest for vividness across groups (H: 20.50, NH= 21.55, Control=21.65). No significant interaction effects (Groups X content= not significant).	• Vivid imagery: Significantly less vividness of imagery for individuals with hallucinatory experiences ($p<0.01$ & $p<0.05$). • Controllability of imagery: Significantly less controllability for individuals with hallucinatory experiences during emotional interpersonal imagery conditions ($p<0.05$).
Heilbrun et al., (1983)	Clinical: 30	Process patients (H experiences and NH experiences) less capable of clear imagery in either auditory or visual than reactive patients Higher error rates for spatial location of voice for hallucinatory experiences (process) than other groups ($p<0.001$).	• Auditory/visual imagery: Individuals with hallucinatory experiences had significantly less preferences for auditory imagery than visual imagery ($p<0.05$).
Mintz & Alpert, (1972)	Clinical: 60 (20 clinical controls)	17 H-SZ reported high vividness, only 3 reported low vividness of imagery (those who reported least frequent hallucinatory experiences). 19 NH-SZ reported lower vividness of imagery, with only one reporting higher vividness. 12 controls reported low vividness, but 8 controls also reported high vividness of imagery.	• Vividness of imagery: Significantly higher vividness of imagery for individuals diagnosed with schizophrenia who had hallucinatory experiences ($p<0.001$).
Starker & Jolin (1984)	Clinical: 70	No significant effect for hallucination presence and visual imagery (high, medium, low %) ($X^2=1.8$). Significant effect for hallucination presence and auditory imagery. H reported higher percentage of auditory imagery. No significant effect for vividness of imagery (auditory or visual) in t-tests (p=ns).	• Vivid auditory imagery: Significant higher means for those with hallucinatory experiences (p=<0.05). • Presence of auditory imagery: Significant higher presence for those with hallucinatory experiences($p<0.05$).

[3] ● = Positive; ● =Negative; ● =No relationship

Non-clinical samples			
Aleman, Böcker & de Haan (1999)	Non-clinical: 57 students	Higher imagery vividness for high LSHS than low LSHS group (BVS total mean scores= 23.7 SD 5.4 vs 27.1, SD 7.1; BVS-visual mean scores= 13.0, SD 3.3 vs 14.6, SD 3.6; Imagery perception mean scores: 2.5, SD 1.4 vs 1.7, SD 1.7). Less imagery vividness for high LSHS (compared with low LSHS) on behavioural tasks than for low LSHS, but no significant difference (p=0.069).	• Vividness of imagery: No significant differences in vividness of imagery between high LSHS and low LSHS groups (p=0.069). • Visual imagery: No significance between BVS visual and LSHS groups (p<0.08).
Aleman, Nieuwenstein, Böcker , de Haan (2000),	Non-clinical: 26 students	High LSHS report more vivid images than low LSHS (mean scores 34.1 SD 6.2 vs 37.5 SD 8.6) (lower scores=more vivid). Behavioural tasks: High LSHS significant positive correlations with visual imagery (p<0.01), auditory (p<0.05).	• Visual imagery: BVS visual and VVIQ (for both p < .05), behavioural task (p<0.01). • Auditory imagery: Not significant (p >.10), • but significant and positive correlations for behavioural task (p<0.05). • Musical imagery: Both groups had significant positive correlations (High LSHS: p<0.01, low LSHS, p<0.05).
Aleman, Böcker & de Haan (2001)	Non-clinical: 57 students	Positive significant correlations between visual imagery and LSHS scores (p<0.01), but no significant correlations for auditory (sound comparison; p= ns. BVS; p=ns).	• Visual imagery: Positive (ρ=0.38, p<0.01). • Auditory imagery: Not significant (,p=ns & p=ns).
Aynsworth, et al., (2017)	Non-clinical: 47 students	HVH scoring group had more vivid imagery on VVIQ (mean scores: 34.35, SD 9.71 vs 39.90) [higher scores=lower vividness of imagery], and also on SUIS mean scores (41.64 SD 8.72 vs 36.62, SD 8.15).	• Vividness of imagery: No significant differences (p=0.91). • Negative imagery: Greater levels for HVH group (p=0.023). • Positive imagery: No significant differences (p=0.86).

Barrett (1993a)	Non-clinical: 62 students	H reported imagery as more vivid (lower mean score) than NH. Scores for imagery ranged between 2.66-3.21 for H vs 2.83- 3.51 for NH (for each type of imagery: visual, auditory, cutaneous, kinaesthetic, gustatory, olfactory, organic).	• Vividness of imagery: Significantly higher vividness of imagery for students with hallucinatory experiences (p<0.0001).
Barrett (1993b)	Non-clinical: 62 students	H reported more vivid imagery than NH for Cutaneous, Kinesthetic, Olfactory and organic (H vs NH: Mean scores: Cutaneous, 2.01 SD 0.85 vs 2.20 SD 1.51; Kinesthetic, 1.88 SD 1.25 vs 2.03 SD 1.24;Gustatory 2.53 SD 1.52 vs 2.47 SD 1.42; Olfactory 2.06 SD 1.44, vs 2.18 SD 0.95;Organic 1.51 SD 0.63 vs 1.75 SD 0.77).	• Vividness of imagery: No significance between students with hallucinatory experiences and non-hallucinatory experiences (p<1].
Glazer et al., (2013)	Non-clinical: 55 (students /other non-clinical)	Presence of imagery associated with greater scores on LSHS-R and measures of unusual experiences (LSHS-R: Mean scores for; Intrusive image absent= 9.29 (SD 5.56), intrusive image present=15.64 (SD 7.36): p<0.01; O-LIFE: Mean scores for; Intrusive image absent= 3.32 (SD 2.14), intrusive image present=4.62 (SD 2.19): p<0.05). No significant correlations for imagery characteristics and LSHS-R scores (Frequency: 0.11, ns; Sadness, -0.16, ns; Anxiety, -0.19, ns; Happiness, -0.18, ns; Vividness, 0.08, ns; Nowness, 0.01, ns; Sensory detail, -0.11, ns).	• Presence of mental imagery: Significantly greater scores on LSHS-R linked to presence of imagery (p<0.01). • Mental imagery: No significant correlations between hallucination proneness and imagery characteristics.
van de Ven & Merckelbach (2003)	Non-clinical: 108 students	Students with hallucinatory experiences reports had significantly more vivid imagery, and higher CEQ/fantasy proneness than those without hallucinatory experiences (p=0.02), with fantasy proneness of a predictor of hallucinatory reports (CEQ, p<0.01).	• Vividness of imagery: Higher in students with hallucinatory experiences than those with non-hallucinatory experiences (p=0.01).

Clinical and Non-clinical samples			
Böcker, et al., (2000)	Clinical: 32 Non-clinical: 14 (healthy controls)	Less vivid visual imagery for hallucinating service users than non-hallucinating service users. Significant difference between paired t tests show z scores for imagery-perception interaction for hallucinating service users had a significant difference between both modalities (p=0.072; non-hallucinating p=ns) .	• Vividness of imagery: Hallucinating service users had less vivid imagery than non-hallucinating service users. • Reality discrimination: Significant negative correlations for all hallucinations (p<0.05), auditory hallucinations (p<0.05). • No significant correlations for other PANSS scores (p=0.055).
David & Cutting (1992)	Clinical: 78 Non-clinical: 30 (healthy controls)	No significance for hallucination x condition x field interaction (p=0.2). Visual hallucinators faster reaction times than non-hallucinators on semantic task (827.9 SD 168 vs 950.6 SD 236, t test= p=0.06) but not for imagery task (897.9 SD 171 vs 992.4, SD 992.4, SD 241, p=0.2). Significant findings for right hemispheres (p=0.04), not significant findings for left hemispheres (p=0.2).	• Mental imagery: No significant correlations for LSHS scores and imagery tasks (barring neural correlates for semantic task). • Semantic: Significantly faster reaction times for visual hallucinators (p=0.06). • Imagery task: No significant differences between groups (p=0.2).
Oertel et al., (2009)	Clinical: 52 (SZ)+ 44 (relatives) Non-clinical: 48	Significant differences for VMI mean scores between SZ and relatives (p=0.025), and between SZ and low ST (p<0.001). SZ groups had less vivid imagery than relatives, but more vivid imagery than the low ST group. No significant differences between high ST and SZ groups.	• Vividness of imagery: Significantly higher vividness (VMI scores) in SZ than ST (p<0.001) • but significantly lower vividness in SZ than relatives (p=0.025). • No significant correlation between LSHS or PANSS scores and VMI, or for specific sensory modalities (p>0.2).

Sack et al., (2005)	Clinical: 50 Non-clinical: 50 (healthy controls)	Higher vividness in imagery for SZ than controls on the QMI, but no significant correlations between hallucination measures and imagery measures.	• Vividness of imagery: SZ higher vividness of imagery on QMI than controls ($p<0.001$). • No significant correlations between LSHS nor SAPS/SANS and mental imagery (LSHS; p=ns; SANS; SAPS; p=0.480).

Key

Characteristics
HVH= High Visual Hallucinating
LVH= Low Visual Hallucinating
R= First Degree Relatives
ST= Schizotypal
SZ=Schizophrenia

Mental Imagery measures
BVS= Betts Vividness of Imagery Scale
QMI= Questionnaire of Mental Imagery
SUIS=Spontaneous use of imagery scale
VMI=Vividness of Mental Imagery
VVIQ= Vividness of Visual Imagery Questionnaire

Hallucination Measures
LSHS=Launay-Slade Hallucinations Scale
PANSS= Positive and Negative Symptoms Scale
SAPS= Scale for Assessment of Positive Symptoms
SANS= Scale for Assessment of Negative Symptoms

Other measures
CEQ= Creative Experiences Questionnaire
O-LIFE=Oxford-Liverpool Inventory of Feelings and Experiences

3.2. Risk of bias

The quality assessments for the studies are shown in Table 3. Six of the 15 studies (included in the review) were quality assessed to have a rating above 50%, with the remaining nine studies assessed to be below 50% in quality. Most commonly, methodological problems related to sample size; particularly in terms of justification for their size and representativeness of the sample. Only two studies considered and detailed the representativeness of the samples used (Böcker et al., 2000; Sack et al., 2005), and only one paper included a power calculation to establish a sufficient sample size to test the research hypotheses (Aynsworth et al., 2017). Problematically, two papers recruited participants exclusively from veteran hospitals (Brett & Starker, 1977; Starker & Jolin, 1984). The findings of these studies may have limited generalizability to adult mental health populations and non-clinical populations prone to experiencing hallucinations.

Sample sizes in all the studies were small (n<108) with studies involving only non-clinical samples having sample sizes ranging between 26-108 participants, whereas studies involving clinical groups had sample sizes between 30-70 participants. Only four studies assessed the internal consistency of the measures used (Aynsworth et al., 2017; Oertel et al., 2009; Sack et al., 2005; van de Ven & Merckelbach, 2003).

Moreover, none of the studies stated that service users/experts by experience were involved in the design of the study. This potentially undermines the extent to which the research conducted to date is relevant to the needs and priorities of experts by experience.

Table 3: *Risk of bias assessment (full scores in appendices)*

Study	Total	Total percentage	Final agreed percentage
Aleman, Böcker & de Haan (1999)	Rater 1:19/42 Rater 2:19/42	45.24% 45.24%	45.24%
Aleman, Böcker & de Haan (2001)	Rater 1:16/42 Rater 2:16/42	38.10% 38.10%	38.10%
Aleman et al., (2000)	Rater 1:18/42 Rater 2:18/42	42.86% 42.86%	42.86%
Aynsworth et al., (2017)	Rater 1:25/42 Rater 2:25/42	59.24% 59.24%	59.24%
Barrett (1993a), USA	Rater 1:20/42 Rater 2:20/42	47.62% 47.62%	47.62%
Barrett (1993b), USA	Rater 1:20/42 Rater 2:20/42	47.62% 47.62%	47.62%
Böcker et al., (2000)	Rater 1:23/42 Rater 2:23/42	54.76% 54.76%	54.76%
Brett & Starker (1977)	Rater 1:18/42 Rater 2:16/42	42.86% 38.10%	38.10%
David & Cutting (1992)	Rater 1:24/42 Rater 2:22/42	57.14% 52.38%	52.38%
Glazer et al., (2013)	Rater 1:22/42 Rater 2:22/42	52.38% 52.38%	52.38%
Heilbrun, Blum & Haas (1983)	Rater 1:16/42 Rater 2:16/42	38.10% 38.10%	38.10%
Mintz & Alpert, (1972)	Rater 1:18/42 Rater 2:16/42	42.86% 38.10%	38.10%
Oertel et al., (2009),	Rater 1:27/42 Rater 2:27/42	64.29% 64.29%	64.29%
Sack et al., (2005)	Rater 1:22/42 Rater 2:23/42	52.38% 54.8%	52.38%

Starker & Jolin (1984)	Rater 1:26/42 Rater 2:23/42	61.90% 54.76%	54.76%
van de Ven & Merckelbach (2003)	Rater 1:20/42 Rater 2:20/42	47.62% 47.62%	47.62%

3.3. How is mental imagery measured in the context of hallucinations?

Nine studies utilised the LSHS; three studies used the original version (Launay & Slade 1981), five used the revised version (Bentall & Slade, 1985), whereas one study used a revised version developed by Morrison, Wells and Nothard, (2000). Other hallucination measures included the VHQ (one paper; Barrett, 1993 a,b), PANSS (one study; Böcker et al., 2000) and the SAPS (one study; Sack et al., 2005). Four studies that only utilised clinical records and observations of hallucinations were included due to the context of these papers (dated prior to the development of robust hallucination measures).

Mental imagery was assessed by self-report measures (n=6), behavioural tasks (n=1) or a combination of self-report measures and behavioural tasks (n=8). Self-report measures focused either on reports of the vividness of mental imagery (either general mental imagery or specific kinds like auditory mental imagery). Self-report imagery measures included Betts Vividness of Imagery [BVS] (n=7; Richardson, 1969), Spontaneous Use of Imagery Scale [SUIS] (n=1; Reisberg, Pearson, & Kosslyn, 2003), Vividness of Visual Imagery Questionnaire [VVIQ] (n=2; Marks, 1973), Intrusive Imagery Interview (n=1; Brewin et al., 2010) and the Vividness of Mental Imagery [VMI] (n=3; Sheehan, 1967).

Other measures assessed beliefs about imagery such as controllability of auditory imagery (n=1; Gordon, 1950) or processes within imagery such as the imaginal processes inventory (n= 2; Singer & Antrobus, 1966) and reality discrimination (n=2; Harvey, 1985; Morrison & Haddock, 1997). In terms of behavioural tasks, the vivid imagery task (n=3; Mehta, Newcombe, & de Haas, 1992), sound comparison task (n=1; Mehta et al., 1992), and just noticeable differences tasks [perception task] (n=1; de Haan, Heywood, Young, Edelstyn, &

Newcombe, 1995), were used. Behavioural measures tended to examine responses to specific tasks that either evoke mental imagery or to maintain mental imagery. For instance in the visual imagery task (Mehta, et al., 1992), participants were presented with object names on cards (imagery task) and line drawings (perceptual), and asked to indicate the odd one out, where participants would have to form mental imagery of the object in order to provide the correct response. Some studies utilised cognitive tests such as visual cognition tasks (n=1, David & Cutting, 1992; Snodgrass & Vanderwart, 1980), or a voice location task (n=1, Heilbrun, Blum, & Haas, 1983), and one study utilised a preferred imagery task to assess whether people showed greater/lesser preference for auditory relative to visual imagery (n=1; Heibrun, Blum, & Haas, 1983).

Eleven studies did not report internal consistency figures for the measures used to assess mental imagery. For the studies that did (n=4), the Cronbach's alpha values ranged from 0.73 - 0.98. These included figures for the QMI (n=2; α = 0.77 & 0.98), VVIQ (n=1 study; α =0.73) and the VMI (n=1; α =0.97). However, older studies such as Brett and Starker (1977) and Mintz and Alpert (1972) may be limited in their analyses of reliability and validity of the measures used, such as the VVIQ (Marks, 1973), with recent studies finding lower internal consistency of the measures and need for revision of these measures (Campos, 2011).

A majority of the studies also focused on vividness of imagery, with hypotheses linked to potential levels of vivid imagery influencing hallucination proneness. However, across the studies, there were variations in how this was assessed, with only a small selection (n=3) utilising behavioural tasks to identify potential discrepancies between self-report and actual behavioural responses/ experience of mental imagery. Within this review, five studies (Aleman et al., 2000;

Aleman et al., 2001; Heilbrun et al., 1983; Oertel et al., 2009; Starker & Jolin, 1984) explored concepts of mental imagery across dimensions in terms of sensory modalities (auditory, visual and musical). Furthermore, two studies (Aynsworth et al., 2017; Glazer et al., 2013) examined interpretations of mental imagery (such as negative, intrusive, positive).

Although there seemed to be similar findings between the studies, there may be implications for the variation in definitions and how the measures were operationalised to fit those definitions. Problematically, validity seemed to have not been considered within the studies either, with no reports of this or the potential impact on the results.

3.4. Is there an association between mental imagery and hallucinations?

Overall, ten out of the 15 studies explored vividness of mental imagery in its relation to hallucinations (see Table 2.). Within these studies, there appeared to be mixed results with five papers (Aleman et al., 2000; Barrett, 1993a; Barrett, 1993b; Mintz & Alpert, 1972; Oertel et al., 2017; van de Ven & Merckelbach, 2003) detailing results of higher vividness of mental imagery in individuals who hallucinate. In addition, two papers (Böcker et al., 2000; Brett & Starker, 1977) detailed the opposite result (lower vividness of imagery in those with hallucination proneness/experience hallucinations), and three studies found no significant differences (Aynsworth et al., 2017; Barrett, 1993b; David & Cutting, 1992).

For those that reported correlation analyses, there were two studies reporting a significant positive correlation between standardised measures of mental imagery and both: visual imagery ($\rho=0.38$, $p<0.01$; Aleman et al., 2001) and musical imagery ($\rho=0.62$, $p<0.01$ Aleman et al., 2000). On the other hand, Aleman et al. (2000) reported a mixed picture of results. This study reported significant positive

correlations for visual imagery and auditory imagery behavioural tasks (Visual; $\rho=0.64$, $p<0.01$; Auditory; $\rho=0.45$, $p<0.05$), yet found significant negative correlations for visual imagery self-report ($\rho=-0.40$, $p<0.05$), and no significant findings for auditory self-report ($p>0.10$). Moreover, four other studies reported no significant correlations between hallucinations and self-report measures of mental imagery (David & Cutting, 1992; Glazer et al., 2013; Oertel et al., 2009; Sack et al., 2005).

Other studies explored intrusive imagery (n=1; Glazer et al, 2013), reality discrimination (n=2; Aynsworth et al., 2017; Böcker et al., 2000), or presence of visual/auditory imagery (n=2; Brett & Starker, 1977; David & Cutting, 1992). In terms of reality discrimination, one study (Böcker et al., 2000) found a significant negative correlation between reality discrimination and hallucinations, and in Aynsworth et al.'s (2017) study, there were significant differences between groups in those with high visual hallucination proneness who were more likely to misattribute pictures for words. Glazer et al. (2013) found higher scores on the LSHS led to significantly greater scores on presence of imagery reports, though there were no significant correlations for intrusive imagery or other types of imagery. Moreover, Heilbrun et al. (1983) found there was less preference for auditory imagery than visual imagery in individuals with hallucinatory experiences.

In terms of specific forms of mental imagery, in those studies that explored this (n=8), five studies explored visual imagery, one study included musical imagery (Aleman et al., 2000) three studies examined auditory imagery, and one study examined positive and negative imagery. Within visual imagery, two studies found people who experience hallucinations had significantly more vivid visual imagery (Aleman et al., 2001; Aleman et al., 2000), though three studies found no significant

findings for visual imagery in relation to hallucinatory experiences (Aleman et al., 1999; Aynsworth et al., 2017; David & Cutting, 1992).

In terms of auditory imagery, there were mixed findings, with Brett and Starker (1977) finding those diagnosed with schizophrenia and actively hallucinating had significantly less vivid auditory imagery during an emotional interpersonal imagery task than individuals without hallucinatory experiences (controls and non-hallucinating individuals diagnosed with schizophrenia). Starker and Jolin(1984) also noted a similar pattern of difference, whereas Mintz and Alpert (1972) found significantly higher auditory imagery in those diagnosed with schizophrenia and actively hallucinating.

As previously discussed, there were significant positive correlations between musical imagery and hallucinations (Aleman et al., 2000). Moreover, one study (Barrett, 1993b), examined imagery across sensory modalities (cutaneous, kinaesthetic, olfactory, gustatory, organic), reporting more vivid imagery on those domains for individuals with hallucinatory experiences than those without. However, these findings were not statistically significant.

In comparing clinical and non-clinical samples with hallucinatory experiences (n=4), there appeared to be higher vividness in clinical samples, with three studies reporting significantly higher vivid mental imagery/reality discrimination scores for clinical samples who experienced hallucinations, in comparison to non-clinical samples (Böcker et al., 2000; Oertel et al., 2009; Sack et al., 2005). However, one study (David & Cutting, 1992), found no significant differences between clinical and non-clinical samples for mental imagery.

For studies that examined only clinical samples (clinical samples with and without hallucinations) (n=4), there were mixed findings, with two studies (Mintz &

Alpert, 1972; Starker & Jolin, 1984) reporting significantly higher mental imagery (vividness) in clinical samples with hallucinations. In contrast, two studies found the opposite (Heilbrun et al., 1983; Brett & Starker, 1977), and rather less vivid mental imagery in clinical samples with hallucinations.

In comparison, non-clinical only samples (n=7) found significantly higher vividness of imagery for those with hallucination proneness (Aleman et al, 2000; Aleman et al., 2001; Barrett, 1993a; van de Ven & Merckelbach, 2003), though four studies were statistically insignificant for vividness of imagery (Aleman et al., 1999; Aynsworth et al., 2017; Barrett, 1993b; Glazer et al., 2013).

Moreover, for those studies that explored specific hallucinatory experiences (visual/auditory), there were mixed findings. In terms of visual hallucinations (n=2), there were no significant differences or correlations in mental imagery in comparison to no hallucinations/low hallucination proneness (Aynsworth et al., 2017; David & Cutting, 1992). However, for auditory hallucinations (n=1), in Barrett (1993a) there was significantly more vivid imagery for auditory hallucinations than for those with no hallucinations, though this result was not repeated in their second study (Barrett, 1993b)

4. Discussion

There has been debate as to whether there is a relationship between mental imagery and hallucinations. In particular, research has explored whether peoples' propensity to experience mental imagery in certain ways may be associated with hallucinatory experiences (Morrison, 2001; Moseley et al., 2016; Pearson et al., 2015). This may have important implications for the assessment, formulation and psychological interventions for hallucinations.

Aiming to examine the existing literature for associations with mental imagery and hallucinations, this current systematic review serves to highlight the mixed nature of research findings to date. Underpinning these aims, this systematic review also intended to explore how mental imagery is measured within the context of hallucinations, alongside assessing the quality of research within this area. As far as the author is aware, this is the first systematic review to explore mental imagery within the context of hallucinations.

Overall, this review found the majority of papers focused on concepts of mental imagery vividness, with six papers reporting higher vividness in mental imagery for individuals with hallucinatory experiences/hallucination proneness in comparison to those without hallucinatory experiences. Other aspects of mental imagery explored with the literature appeared to focus on the presence of mental imagery (i.e. intrusive and valence (positive vs. negative) of imagery) or sensory modality of mental imagery (e.g. visual/auditory mental imagery). These findings may have implications for theoretical understanding about processes potentially involved in differentiating between mental imagery and hallucination such as external misattribution bias (Jones & Fernhough, 2007; Martin et al., 2017; Morrison, 2001). It may be, for example that individuals with hallucinatory experiences and higher vividness of mental imagery may have difficulties in discriminating between mental imagery and actual perceptual experiences. However, this understanding is contradicted by three papers reporting statistically insignificant results in terms of the relationship between mental imagery vividness and hallucinations (both visual and auditory), and two papers finding a significant inverse relationship (significantly less mental imagery vividness in those with hallucinatory experiences than those without). Furthermore, for those studies that examined correlations, four papers

found no significant correlations between mental imagery and hallucinatory proneness, and only two papers found significant positive correlations between mental imagery and hallucinations, and there appeared to be no clear correlations for self-report and behavioural measures. The results may also have been affected by the inclusion of dated papers where due to context, measures and analyses may have been limited (Pearson et al., 2013). However, these papers needed to be included due to influencing the development of considering mental imagery as a measurable construct and its' potential implications within psychological difficulties (Pearson et al., 2013).

In terms of mental imagery measures, the main measures used was; Betts Vividness of Imagery (BVS; Richardson, 1969), Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973) and Vividness of Mental Imagery (VMI; Sheehan, 1967), again supporting that majority of the papers in this review focused on the vividness of mental imagery. Within these measures, there appeared to be assumptions that self-report mental imagery measures are sufficient, which may have been complicated by one study (Böcker et al., 2000) finding conflicting findings between self-report and behavioural tasks for mental imagery. This may link to potential response bias or social desirability effects that can be found within self-report measures (DeVylder & Hilimere, 2015).

Furthermore, the papers within this review appeared to focus only on general hallucination propensity, assessed either through the Launay Slade Hallucinations Scale (LSHS), or clinical interviews (such as the PANSS) for clinical samples. Therefore the mixed results may link to variations in the experiences of mental imagery for different types of hallucinations, with only two studies explicitly

examining visual hallucinations (Aynsworth et al, 2017; David & Cutting, 1992), and one study (Barrett, 1993) examining auditory hallucinations.

4.1. Methodological considerations

4.1.1. Risk of bias in the included studies

In terms of methodological quality (through the use of QATSDD), key methodological strengths of the studies were; clear theoretical frameworks, aims/hypotheses, alongside appropriate data collection and analyses in relation to the paper's aims. However, key methodological limitations were linked to the sample sizes used, representativeness of these samples and the studies design, which will be discussed in more detail.

Although small sample sizes were used within the studies, this may be reflective of difficulties in participant recruitment/attrition rates in clinical populations, alongside the potential figures of clinical samples with hallucinations (Bucci et al., 2015; Patel et al., 2017). This may also have contributed to 14 of the studies not reporting power calculations. Owing to small sample sizes, it is likely that these studies were underpowered, which highlights a need for caution when interpreting study findings. The majority of studies did control for age and gender, but none of the studies controlled for education. These factors may have impacted on responses to measures (Westfall & Yarkoni, 2016).

None of the studies assessed potential cultural factors, which may have played a role in how measures and the concepts were interpreted alongside potential variations in hallucinatory experiences (Larøi et al., 2014; Luhrmann et al., 2015). However, despite potential confounding factors within self-report measures, for those studies that assessed internal consistency of measures (n=4), these fell within moderate to high ranges (α= 0.73 -0.98).

Study designs were also limited within the papers, mainly utilising a cross-sectional/experimental design. The lack of longitudinal studies and the largely correlational nature of the research limits the extent to which causal links can be made between mental imagery and hallucinatory experiences. Moreover, the use of only cross-sectional designs restricts our understanding of mental imagery to a static rather than dynamic construct. There is potential for aspects of mental imagery, including vividness, to change over time and across different contexts. Similarly, it has been suggested that the propensity to experience hallucinations varies across different contexts (Kidd, 2013; Langer et al., 2015; Stinson, et al., 2010).

It is also suggested that hallucinations can be on a spectrum (Baumeister et al., 2017; Schlier, Hennig, & Lincoln, 2017), therefore studies exclusively focusing on clinical or non-clinical populations (rather than mixed groups) may not capture the breadth of hallucinatory experiences and limit understanding about how hallucinations link to other experiences such as emotional distress (Edwards & Bagozzi, 2000). This may also impact on efforts to understand the relationship between mental imagery and hallucinations.

It is possible that medication taken by participants in some of the studies may also have been a confounding factor in understanding the association between mental imagery and hallucination. For instance, adverse effects or sedation levels may have impacted on performance on mental imagery measures and/or suppressed hallucination propensity. Other potential confounding factors include, substance use, trauma or other psychiatric diagnoses that were not screened for in the clinical or non-clinical samples.

4.1.2. Limitations of systematic review

Within this review, a meta-analysis could not be undertaken due to: 1) the heterogeneity of the studies in terms of assessment measures used to assess hallucinations and mental imagery; 2) heterogeneity in sample size/characteristics. There was also a risk of potential publication bias, as studies reporting small effect sizes and/or statistically insignificant findings are less likely to have been published.

As with any systematic review, there is a risk that the search strategy employed may have missed or inadvertently excluded eligible studies from the review. However, the risk of this was mitigated through thorough scoping searches and piloting of search terms. It is important to note that 11 studies identified in the search were excluded on the basis that they were not available in the English language. This limits the conclusions that can be drawn about the relationship between mental imagery and hallucinations.

4.2. Clinical Implications

The results from this systematic review have a number of potentially important clinical implications particular in relation to the use of psychological therapies. Compassion Focused Therapy (Gilbert, 2014) utilise imagery to activate the affiliation system and address psychological difficulties. In addition, specific psychotherapies address mental imagery that may be maintaining psychological difficulties (such as within Cognitive Behavioural Therapies, Eye Movement Desensitization and Reprocessing Therapy, or Schema Therapy; Pearson et al., 2015). Increasingly these therapies are being used to help people experiencing problematic hallucinations (e.g. Braehler et al., 2013; Gumley et al., 2010; Morrison & Barratt 2009; Turkington, Wright, & Tai, 2013).

Although not a specific aim of this review, the results obtained appear to support the legitimacy of employing mental imagery in psychological therapies for conditions such as psychosis. Five studies found a predisposition for vividness of imagery in those experiencing hallucinations; if linked to emotional distress it may be a potential maintenance factor of the difficulties (Weßlau & Steil, 2014). In considering different treatment options it may also be beneficial to assess individuals' capacity to experience vivid imagery, so that interventions can be tailored to the individual. For example, if an individual has an enhanced capacity to generate positive imagery or images that may help internalise coping strategies for distress then utilising mental imagery in psychotherapy may be indicated (Ascone et al., 2017; Laing, Morland, & Fornells-Ambrojo, 2016; Sheaves, Onwumere, Keen, & Kuipers, 2015). Moreover, this highlights a potential need for developing robust tools that assess helpful/unhelpful mental imagery. This also highlights a need to consider mental imagery within psychological formulations, particularly for therapy focusing on hallucinatory experiences.

4.3. Future Directions

Due to some ambiguity and heterogeneity in how the term 'mental imagery' is deployed and how it is assessed, future research should aim to achieve greater consistency in how mental imagery is defined and assessed. Further research is needed to assess the use and impact of mental imagery within psychological therapies for hallucinations and other similar experiences - particularly as there appears to be mixed findings around the relationship between mental imagery and hallucinations. Future research should explore in more detail how distinct aspects of mental imagery (e.g. vividness, intrusive, valence and sensory modality) are differentially linked to distinct types of hallucinations (e.g. auditory/visual/tactile). This

should include a focus on exploring how contextual factors might impact on these relationships, and what factors may contribute to the treatment of hallucinations and/or associated distressing mental images.

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Chapter Two: Empirical Research

Taxometric Analysis of Hallucinations: Are Hallucinatory Experiences Dimensional or Taxonic?[4]

[4] Article prepared for submission to Schizophrenia Research. Appendices G-I for thesis submission only. Not to be submitted to target journal.

Abstract

Background

There remains an ongoing debate around whether symptoms of psychosis lie on a continuum or are taxonic. This issue has important implications for the classification, assessment and treatment of psychosis. Recent research has highlighted specific aspects of psychosis such as paranoia have a dimensional latent structure. It remains to be seen if other aspects of psychosis share this dimensional nature.

Aims

This study aimed to explore whether hallucinations are taxonic or dimensional structures.

Methods

Taxometric methods were applied to a dataset of clinical (n=290) and non-clinical (n=1580) participants who had completed the Launay-Slade Hallucinations Scale-revised (LSHS-R). Analyses were initially conducted with a non-clinical group before a clinical group was added into the data for analysis; reducing the likelihood of producing a pseudo-taxon.

Results

Three out of six taxometric analyses found a dimensional result (non-clinical sample; MAXEIG and L-Mode analyses. Whole sample; MAXEIG analysis). The other three results produced ambiguous solutions (non-clinical sample; MAMBAC analysis. Whole sample; MAMBAC and L-Mode analyses).

Discussion

Although there was some indication of ambiguity in the findings, there are some indications that hallucinations, like paranoia, are dimensional. Clinical implications of these findings are discussed. Potential issues with the LSHS-R mean that the results should be interpreted with caution. The development of additional scales or assessments for hallucinations that can be used with both non-clinical and clinical populations is recommended.

Keywords: Hallucinations, taxometric methods, Launay-Slade Hallucinations Scale-Revised

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1. Introduction

In recent years, there has been an ongoing debate about whether symptoms of psychosis exist on a continuum of severity with sub-clinical signs and traits that exist across general population samples (Lawrie et al., 2010). This is contrasting to psychiatric diagnostic classifications, where psychotic disorders, such as schizophrenia and schizoaffective disorder exist as discrete categories.

Experiences that appear similar to “psychotic” symptoms such paranoia and hallucinations have been found to be common in the general population (Ohayon, 2000). Research studies have previously examined psychotic experiences as a continuum phenomenon (Capra et al., 2015), and assessed the validity and reliability of self-report measures designed to assess psychosis as a continuum phenomenon such as the Community Assessment of Psychic Experiences (CAPE; Capra et al., 2017; Konings et al., 2006) and the Cardiff Anomalous Perceptions Scale (CAPS; Bell et al., 2005). However, these studies have primarily focused on populations at risk of psychotic experiences such as adolescents and people with a history of substance use.

Taxometric methods have been employed to investigate whether psychopathological constructs exist as categories or are a continuum phenomenon (Haslam, 2003; Meehl, 1995; Ruscio et al., 2013). Recent research using these methods has examined psychiatric diagnoses such as schizophrenia (Ahmed et al., 2012; Cuesta et al., 2007), eating disorders (Olatunji et al., 2012), depression and anxiety (Olatunji et.al., 2010).

According to (Brown, 2001), this research has sought to determine whether psychopathological constructs exist that differentiate ‘*a conjectured taxon group*

(e.g., persons with the target disorder or vulnerability) from a complement group (e.g., normal controls, persons with disorders other than the target condition)' (p534).

Taxometric methods were developed by Meehl (1992, 1995), aiming to establish a similar system to ecology (ecological systems classification) for understanding variations within the psychological phenomenon. Meehl's (1992,1995) aims were to explore variations through examining potential differences and similarities between set groups (classifications) on the assumption that, if there are distinct differences between the groups, there will be a taxon (taxonic group), whereas if there are similarities between the groups and within group variations, there will be a dimensions.

The assumption within this model is that variations within psychological phenomena, such as anxiety can be statistically assessed in order to identify a taxon regardless of whether the phenomena is tangible or not. Meehl (1999) argues that this approach is not pro or anti-category. Meehl (1999) also argues that the DSM-IV (Diagnostic and Statistical Manual of mental disorders) may have limitations in that it does not represent taxons sufficiently. Within this argument, Meehl (1999) explains that many individuals do not necessarily fit the DSM's categories, potentially due to dimensionality within their experiences. However, he argues that schizophrenia and bipolar affective disorders are potentially taxonic, leading to further research in assessing these through taxometric methods. This has led to further developments in taxometric methods with set standards developed for this type of research within psychiatry (Ruscio et al., 2013).

The taxometric method involves robust interpretational strategies such as quantitative indices and multiple analyses to investigate datasets in more detail (Ruscio et al., 2013). The approach is particularly useful for exploring the dimensions

of these constructs within clinical and non-clinical samples (Lenzenweger, 2010). For example, taxometric methods have been employed in studies of schizotypy and forms of psychotic disorders examining the potential dimensionality of these constructs (Haslam et al., 2012). These have provided mixed results potentially owing to the broad definitions and multitude of experiences within these labels. This has led to more focus on specific experiences of psychosis such as paranoia which was shown to exist on a continuum (Elahi et al., 2017). However, further taxometric studies have not been conducted into other symptoms, such as hallucinations, that can commonly present in all psychotic disorders. This is despite systematic reviews by Johns et al. (2014) and Baumeister et al. (2017) suggesting that hallucinations may also be a dimensional rather than taxonic construct.

Key criticisms relating to categorical approaches for classifying mental disorders are based on heterogeneity within diagnostic categories, and homogeneity between them (Beck et al., 2011; Wing & Agrawal, 2003). Moreover, psychotic symptoms can be dynamic, meaning they may change in severity and frequency over time, yet diagnostic labels tend to be rigid and assume stability in symptoms (McGorry et al., 2008). This has implications for clinical practice as currently diagnostic labels like schizophrenia can be negative, stigmatising societal attitudes attached to the label (Burke et al., 2016; Wong et al., 2009; Wood et al., 2015). This may lead to further difficulties and experiences of depression (Stainsby & Lovell, 2014).

Hallucinations refer to perceptions that are not present in objective reality (i.e. sensory experiences that may occur whilst awake that are not perceived by others), which can be of a visual, auditory, tactile or olfactory in nature (Larøi et al., 2004; Larøi & Woodward, 2007). These experiences can vary from simple experiences

(e.g. patterns or noises) to more complex experiences (such as visualisations of people/objects or voices of people speaking) (Joyce & Roiser, 2015). Psychosis apart, hallucinations can also co-occur with other forms of mental health difficulty. For example, hallucinations may coincide with trauma, depression or other similar experiences (Stainsby & Lovell, 2014; Misiak et al., 2016). This may also indicate problems with the validity of the psychiatric classification system (Jablensky, 2016; Read, 2013), due to overlaps in symptoms across diagnostic labels, which may involve potential dimensional qualities within underlying symptoms (Johns & van Os, 2001). Moreover, the potential impact of these experiences may lead to depression or paranoia (Linscott & van Os, 2013).

Hallucinations can have a range of sub-types. For example, auditory hallucinations can be sounds, music or verbal communications (such as comments, commands, and statements). In the DSM V (American Psychological Association, 2013) and the International Classification of Disease (ICD-10;World Health Organization,1992), experiencing hallucinations is listed as a criterion for specific types of mental disorders (such as schizophrenia, schizoaffective disorder, bipolar affective disorder with psychotic features) (Bentall & Varese, 2013). However, diagnostic categories can mask marked heterogeneity in individuals' subjective experiences of hallucination, especially as hallucinations are not necessarily problematic for all people (Choong et al., 2007; McCarthy-Jones, 2012).

In terms of the general population reporting experiencing non-distressing hallucinations, there have been wide variations in reported prevalence rates, with a review by Beavan et al. (2011) stating this can lie between 1-84% (interquartile between 3.1%-19.5%). However, there can be problems with methods employed to assess hallucinations, particularly in epidemiological studies where large numbers

may miss nuances within the data (Stanghellini et al., 2012). These nuances include potential social desirability effects, cultural and contextual interpretation of hallucinations, particularly as the majority of studies rely on student samples, alongside potential grouped factors that may influence hallucinations such as substance use or neurological conditions (Stanghellini, et al., 2012). For instance, Ohayon (2000) found rates as high as 34.7%, but the majority of these was related to sleep hallucinatory experiences, and potentially included clinical samples. Realistically, estimates lie between 1-12% (Tien, 1991) with Kråkvik et al. (2015) and McGrath et al. (2015) finding prevalence rates of 5-8% for auditory hallucinations in the general population. Yet for some individuals, hallucinations can be a very distressing experience that leads to seeking help (de Leede-Smith & Barkus, 2013), with 16% within Kråkvik et al.'s (2015) study seeking professional help.

Within hallucinatory experiences, there also is concepts of frequency, where increased frequency of hallucinatory experiences may impact psychological well-being (Shevlin, Boyda, Houston & Murphy, 2015), even if the hallucinations do not cause distress, yet it tends to be levels of distress that lead to individuals' seeking help (de Leede-Smith & Barkus, 2013). Therefore current measures of hallucinations such as PSYRATS (Psychotic Symptom Rating Scale; Haddock et al., 1999) tend to assess levels of distress, frequency and also beliefs around the nature of the hallucinations (Varese et al., 2016).

Psychological models have been proposed to account for the experiences of hallucinations. Cognitive models such as by Morrison (2001) and Garety et al. (2007), argues for a multi-factorial explanation for hallucinations and psychotic disorders. Garety et al. (2007) argue that psychosis may be linked to a stress-vulnerability, where stress triggers cognitive and emotional changes that lead to

anomalous experiences. Consequently, it is then believed that information processing deficits (Frith 1992, 2005) and pre-existing beliefs about self and others, may lead to misinterpretations of anomalous experiences, leading to maintenance of hallucinatory experiences. Therefore, these misappraisals are believed to be what leads to distress from hallucinatory experiences. Other theories argue for a misattribution bias rather than cognitive deficits, where hallucinations may arise from internal cognitions being misattributed to an external source (Bentall, 1990) as demonstrated within signal detection studies (Rossi et al., 2016; Alganami et al., 2017).

The current study expanded on previous research by Elahi et al. (2017) and Haslam et al. (2012), using *taxometric* methods to identify potential discontinuities within psychopathology focusing on hallucinations. A large secondary data set relating to the assessment of hallucinatory experiences using the Launay Slade Hallucinations Scale (LSHS; Bentall & Slade, 1985) was used for this purpose. The LSHS considers the presence of types of hallucinations and also distress from hallucinatory experiences. Within this approach, there are assumptions that hallucinations are measurable and be assessed objectively through statistical analysis (means, covariance and factorial analyses) of data from set scales (such as the LSHS) to consider whether there is a taxonic or dimensional structure in that specific data (Ruscio, Haslam & Ruscio, 2012). This involves a taxometric method that employs multiple analyses to examine the mean, covariance and factors, and indicators are developed to assess the data (Ruscio, Haslam & Ruscio, 2012). The aims are to assess whether predictable results can be found, when a cutting point is moved through distribution of indicator scores to create subsamples (Meehl & Yonce, 1994).

A taxonic structure (meaning that there are clear categories/classifications) would indicate that the experiences of hallucinations are clearly different and distinguishable in clinical vs. non-clinical populations. Alternatively, a non-taxonic structure would indicate that all individuals can experience hallucinations in varying degrees of intensity, which could reduce the stigma and increase openness associated with hallucinations (Baba et al., 2017; Longdon & Read, 2017). As such, it was hoped that the findings of the study would have important implications for conceptualising, assessing and intervening with hallucinatory experiences.

1.1. Aim of Current Study

This study aims to build upon Elahi et al.'s (2017) taxometric analysis of paranoia by extending the focus to hallucinatory experiences. As such, this study aims to explore whether hallucinations (based on Launay-Slade Hallucination Scale-Revised scores) within clinical and sub-clinical populations are experienced on a continuum of risk or whether they are categorical in nature.

2. Method

2.1. Procedure

Secondary data (anonymised) relating to the Launay Slade Hallucinations Scale-Revised (LSHS-R; Bentall & Slade, 1985) was provided from collaborating researchers through encrypted emails. Datasets only involved adult populations who were able to provide informed consent and had granted permission for their data to be used in future research, and involved clinical and non-clinical samples. A total of 1913 sample size was received; in excess of the number of cases required for taxometric analysis (Ruscio et al., 2011). Missing data for the LSHS-R was removed list-wise, resulting in a final total sample size of 1870 participants (clinical and non-clinical).

Students within the non-clinical sample were recruited through cross-sectional designed studies at Liverpool, Bangor, and Manchester universities. LSHS-R measures were completed in face-to-face interviews or online. Datasets were anonymised prior to provision to the authors of this study, and the availability of socio-demographic data for participants varied between and within the different samples. Clinical samples were recruited through cross-sectional studies. These studies were by Varese et al. (2017), Varese et al. (2011) and Alganami et al., (2017) as well as unpublished studies.

The study was discussed with the Committee of Research Ethics at the University of Liverpool, where it was concluded that due to the study involving large sets of anonymised secondary data, ethical approval was not required. All of the studies from which data had been obtained had received approval from University and NHS research ethics committees. Encrypted data was anonymised prior to sending to the authors of this study to meet the University of Liverpool guidelines for data management and protection (University of Liverpool, 2018).

2.2. Participants

132 (43%) of the clinical sample had completed the Positive And Negative Symptoms Scale (PANSS; Kay et al., 1987) (n=132), 98 (32%) of the clinical sample completed the Psychotic Symptoms Rating Scale (PSYRATS; Haddock et al.,1999) to establish clinical status. However, 75 (25%) of the clinical sample did not complete these assessments, therefore other information was used to attain clinical status.

All of the clinical samples were considered to have forms of psychotic disorders except for 2 (0.7%) who met criteria for Obsessive Compulsive Disorder (OCD). Within the clinical sample, 21 (7%) were considered to be actively hallucinating, 181 (59%) considered to have psychosis and 102 (33%) classed as

non-hallucinating at time of the study. Moreover, only 1870 participants (97% of the 1913 whole sample) had complete data for the LSHS-R, therefore 43 (2%) participants' data was excluded through list-wise deletion from the final analyses.

Non-clinical populations were a mixture of students and healthy controls. Demographic details of both samples are provided in Table 1. There were no significant differences for gender in both groups (p=0.505). The majority of the clinical sample had education levels beyond A level/BTEC (n=137; 45%), with a small proportion stating they had reached GCSE/O level (n=48; 16%), and a small proportion stating they had reached degree level and above (n=45 15%).

Similarly, the majority of the non-clinical sample stated they had reached up to A level/BTEC (n=334; 21%), with a small proportion stating they had reached degree level and above (n=75; 5%) and a small proportion stating they had reached GCSE level (n=25; 1.6%). Only a small proportion of the clinical and non-clinical samples stated they had not received education/obtained educational qualifications (clinical: n=14; 5% non-clinical=1; 0.06%). However, for the non-clinical sample, there was a larger number with no information available for educational level (n=1141; 71%).

Table 1. *Demographic information of both groups*

	Number	Mean Age[a]	Sex	Education
Clinical	N=306	31.24 (SD 13.24) Range 18-66 unknown=1	205 female (67%) 101 male (33%)	None=14 GCSE/O level=48 A level /BTEC=137 University=45 Other=40 Unknown=22
Non-clinical	N=1607	22.29 (SD 6.5) Range 16-72 Unknown age=423	810 female (68%) 381 male (32%) Unknown=416	None=1 GCSE/O level=25 A level/ BTEC=334 University=75 Other=31 Unknown: 1141

[a] *Mann-Whitney test (p=0.00)*

2.3. Measures

2.3.1. Launay-Slade Hallucinations Scale-Revised (LSHS-R)

The LSHS-R is a self-report questionnaire that measures hallucinatory experiences in healthy individuals, who respond to 12 items that explore their past and present experiences on a five-point scale. Total scores range from 0-48, and higher scores indicating greater predisposition to hallucinatory experiences. This five-point scale rates from 0=certainly does not apply, to 4=certainly applies. The LSHS-R has good psychometric properties, (Jones et al., 2008; Fonseca-Pedrero et al., 2010) and good test-retest reliability (Bentall & Slade, 1985). Internal consistency for this study was above a sufficient level (α=0.84). This was comparable to the Positive And Negative Symptoms Scale (PANSS) internal consistency for this study (PANSS; α=0.85).

2.4. Data Analysis

Preliminary analyses involved t-tests and reliability analysis to ensure the data was suitable for taxometric methods. Alongside this, indicators for conducting the taxometric analyses were selected through factorial correlational matrixes, alongside theoretical knowledge around hallucinations (Fonseca-Pedrero et al., 2010; Larøi et al., 2004; Stanghellini et al., 2012). Lowest correlated items were selected also, to act as subscales.

Consistent with the approach utilised by Elahi et al. (2017) and Ruscio et al. (2013), taxometric data analyses were initially run on non-clinical sample data sets before running these on the whole dataset to reduce production of a pseudo-taxon. At least three indicators were identified through measuring correlations between grouped questions on the LSHS-R, and at least three data analyses were to be conducted to produce visual graphs that identified whether data was either categorical or dimensional, alongside written descriptions of the results. Data analyses were conducted to produce graphs, involving Mean Above Minus A Cut (MAMBAC; Meehl & Yonce, 1994), Maximum Eigenvalue (MAXEIG; Waller & Meehl, 1998) and Latent Mode Factorial Analysis (L-Mode; Waller, & Meehl, 1998) analyses.

These analyses were selected based on following protocol for taxometrics by (Ruscio, Haslam & Ruscio, 2013), with each analysis examining a different component to the data such as the mean (MAMBAC), the covariance (MAXEIG), and factorial analyses (L-Mode). MAMBAC uses the assumption that if two groups exist there will be an optimal cutting score to distinguish them, where if a cutting score can be found, a taxon can be assumed to exist (Meehl & Yonce, 1994; Ruscio, Haslam & Ruscio, 2013). MAXEIG aims to assess the associations between two or more output indicators, through calculating the first eigenvalue of a modified covariance

matrix (Waller & Meehl, 1998). L-Mode on the other hand uses Barlett (1937) factor score estimates to graph estimated scores on a single latent factor (Waller & Meehl, 1998). Overall six analyses were conducted (non-clinical; MAMBAC, MAXEIG, L-Mode. whole sample; MAMBAC, MAXEIG, L-Mode).

A Comparison Curve Fit Index (CCFI, Ruscio & Kaczetow, 2009) was utilised to measure the fit of the curves within the produced graphs, where the results are stronger if the deviation score is greater than 0.5 (Ruscio et al., 2013), ideally falling below 0.4 or above 0.6 to be significant. Missing data analyses were also conducted, where if appropriate missing data was resolved through listwise deletion.

3. Results

3.1. Missing data analysis

In total, 43 cases had data missing; 16 had less than 20% completion (7 non-clinical, 9 clinical), 23 with 80% completion (16 non-clinical, 7 clinical), and 4 cases had 40-50% missing (non-clinical only). There were no significant differences between missing data and complete data for demographics (age: p=0.258; gender=p=0.478) or range of LSHS-R scores (total LSHS: p=0.414). Therefore, listwise deletion was completed, resulting in 1870 cases being included in the final analyses (Non-clinical=1580; Clinical= 290).

3.2. Complete data analysis

The characteristics of participants entered into the analyses are listed in Table 2, which similar to the full sample showed there was significant differences for education and age, but no significant differences for gender. Again, these are skewed by high amounts of missing data for education.

Table 2*: Complete data participant characteristics*

Complete data		**Mean Age[a]**	**Sex**	**Education**
Clinical	N= 290	31.14 (SD 13.15) Range 18-66	194 female (67%) 96 male (33%)	GCSE= 46 (16%) A level= 131 (45%) University= 45 (16%) Other=39 (13%) None=10 (3.4%) Unknown=19 (6.6%)
Non-clinical	N=1580	22.3 (SD 6.48) Range 16-72 420=unknown	794 female (68%) 370 male (32%) 416= unknown	GCSE=25 (1.6%) A level=327 (21%) University=70 (4.4%) Other=31 (2%) None=1 (0.06%) Unknown=1126 (71%)

[a] *Mann-Whitney test (p=0.00)*

For complete data of both groups, LSHS-R total scores ranged between 0-48 (mean=16.74, SD=9.6). LSHS total scores ranged from 0 to 48 for the clinical samples (mean=22.3, SD 10.8) and 0 to 46 for the non-clinical samples (mean=15.72, SD 9), with a significant difference for the total LSHS-R scores (F=19.31, t=9.735, p=<0.001, CI: 5.22-7.88). In terms of validity, there were significant positive correlations coefficients between PANSS 3 (hallucinations question) and the LSHS total scores (r=0.279, p<0.01), indicating construct validity.

During development of indicators for the taxometric analyses, the decision was taken to remove spiritual-based items of the LSHS-R (e.g. those relating to the voice of God or the voice of the Devil), as these may link to other experiences, particularly as religiosity was not detailed for either the clinical or non-clinical sample. These items may also be construed as being distinct from hallucinatory experiences by individuals with higher levels of religiosity, potentially impacting on the external validity (the Cronbach's alpha for the total scale remained > 0.80 when these items were removed).

As per the recommendations for taxometric analyses (Ruscio et al., 2011), the lowest correlating items were selected to form subscale indicators (all items: Pearson's correlation= <0.4), which the subscales "Intrusive Vivid Thoughts" (LSHS1, LSHS3, LSHS4; α=0.71), "Vivid Daydreams" (LSHS2, LSHS5, LSHS6; α=0.77) and "Clinical Hallucinations" (LSHS7, LSHS9, LSHS12; α=0.68) were created. Lowest correlated items were selected based on within-group analyses of the whole sample that created a correlational matrix of the scale items, to ensure there was valid interpretation of taxometric curves, where indicators need to be correlated within the full sample, but have minimal correlations within potential taxon and complement groups (Meehl, 1995.

The creation of these subscales was also informed by previous factorial analyses (Fonseca-Pedrero et al, 2010; Larøi et al., 2004), who examined potential indicators based on theoretical roots within hallucination dimensions (Aleman et al., 2001; Levitan et al., 1996; Stanghellini, et al., 2012; Waters et al., 2003). Correlational analyses for the indicators and total LSHS-R scale are shown in Table 3.

Table 3*: Pearson correlations for subscale indicators*

	Intrusive Vivid Thoughts	**Vivid Daydreams**	**Clinical Hallucinations**
Intrusive Vivid Thoughts	-	0.595**	0.460**
Vivid Daydreams	-	-	0.519**

** Significant results, p=<0.01

Taxometric methods analyses results are shown in Table 4. These results are presented for the non-clinical sample (1580) alone, and for the combined non-clinical and clinical sample (1870). Due to clinical samples being likely to report

hallucinations, if a taxon was present it would be more likely to be shown within the whole sample rather than just within the non-clinical sample alone.

Three indicators were used for the analysis (Intrusive Vivid Thoughts, Vivid Daydreams, Clinical Hallucinations), with two datasets (clinical and non-clinical), with three taxometric methods used to analyse the data (MAMBAC, MAXEIG, and L-Mode). The estimated validity of item indicators for the whole sample fell between Cohen's d values of 1.8 and 2.2, which was within the recommended range for taxometric analyses (recommended to be at least 1.5 or above; Meehl, 1995). This was calculated within R stats programme; a requirement prior to conducting taxometric analyses, where analyses are conducted on the whole sample to establish whether item indicators are sufficient. This was calculated through a base rate classification method (Ruscio et al., 2013) that uses the standardized mean differences of the cases assigned to the taxon and complement groups

Overall, a continuous rather than taxonic relationship was found within hallucinatory experiences based on the LSHS-R, with CCFI values ranging from 0.2-0.5. However, three of the six analyses (whole sample; MAMBAC, and L-Mode analyses. Non-clinical; MAMBAC) showed ambiguous findings (CCFI values falling between 0.4-0.6) meaning there was a lack of clear consensus on whether the results were taxonic or dimensional.

Table 4*: CCFI values from taxometric methods analysis using indicators*

	MAMBAC	**MAXEIG**	**L-Mode**
Full sample (clinical and non-clinical) (N = 1870)	0.51[a]	0.302	0.402[a]
Non-clinical sample (N = 1580)	0.4[a]	0.2	0.359

[a] Ambiguous results falling between 0.4 and 0.6

Figure 1. and Figure 2. shows graphical demonstrations of these results; Figure 1. shows non-clinical, whereas Figure 2. shows the whole sample. These graphs represent the CCFI values displayed in Table 4. Within both figures, the grey lines show simulations that reflect potential dimensional or categorical solutions based on parameters of the sample data, and the dark lines show the actual sample data allowing for comparison to establish whether a dimensional or taxonic solution is probable. Therefore, comparing dimensional and categorical graphs for each analysis can help show the most likely solution (the closer the dark lines fit within the grey lines). For instance, the MAXEIG graph in Figure 1. shows a dimensional result, with the dark lines fitting closer to the grey lines in the dimensional graph unlike the dark lines within the categorical graph.

Overall results displayed in the figures show three graphs displaying a dimensional structure (MAXEIG and L-Mode in Figure 1.; MAXEIG graph in Figure 2.). However, three graphs also show ambiguous results (MAMBAC graph in Figure 1.; MAMBAC and L-Mode graphs in Figure 2.).

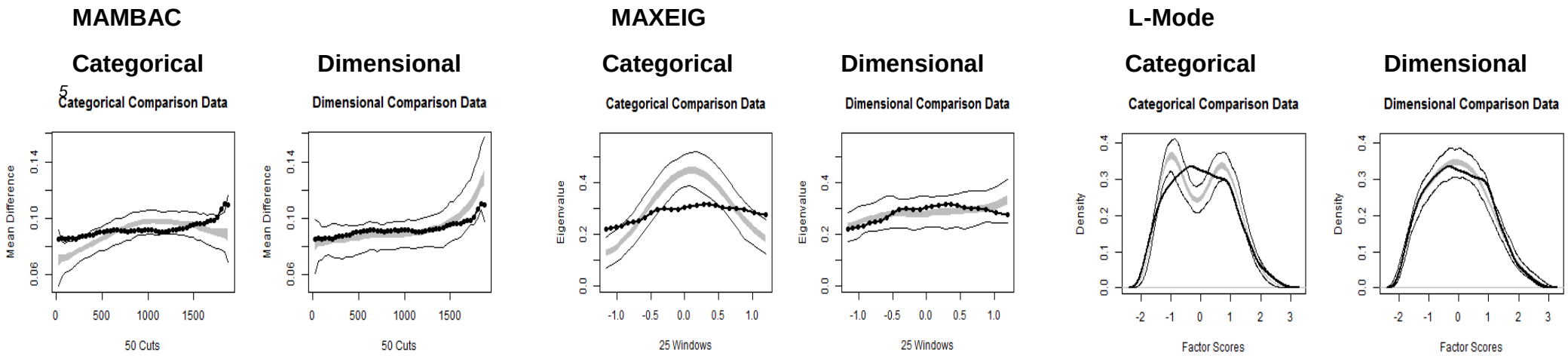

Figure 1*: Visual graphs for taxometric analyses on the non-clinical sample*[5]*.*

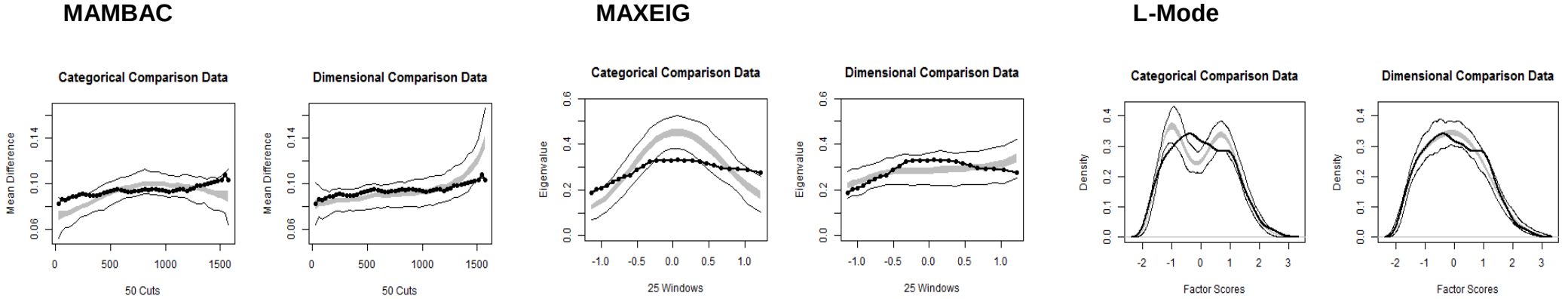

Figure 2: *Visual graphs for taxometric analyses on the whole sample (clinical and non-clinical).*

[5] Data in each analysis uses the three indicators: Intrusive Vivid Thoughts (LSHS1, LSHS3, LSHS4) Vivid daydreams (LSHS2,LSHS5, LSHS6), Clinical Hallucinations (LSHS7, LSHS9, LSHS12).

4. Discussion

As outlined in section 1., this study aimed to explore whether hallucinations are dimensional or taxonic, particularly as this may have implications for interventions for hallucinations, alongside addressing potential issues with classification systems for psychotic disorders and how these are assessed. Within this study, a dimensional structure was found in a large sample based on clinical and non-clinical populations. However, three of the analyses found ambiguous results where there is no clear solution as to whether the data is taxonic or dimensional. As such the results potentially support the hypothesis that hallucinatory experiences exist on a continuum; consistent with findings from other research conducted with non-clinical samples (Rehman, 2017; Shevlin et al., 2016; Unterrassner, et al., 2017).

The findings are also consistent with Ahmed et al.'s (2011) taxometric analysis of schizophrenia, and Rawlings et al.'s (2008) taxometric analysis of schizotypy, who also found dimensional structures. Moreover, this links to Elahi et al.'s (2017) taxometric study of paranoia, which again found a dimensional pattern (Elahi et al., 2017). The findings of the current study stand in contrast to those of Korfine and Lenzenweger (1995), Lenzenweger (1999), Linscott and Morton (2017) and Morton et al. (2017) who found taxonic relationships in schizotypy. However, these studies were limited in terms of samples and potential methodological issues (Haslam et al., 2012). These issues included small samples sizes (n<600), low validity of item indicators, which also leads to potential researcher bias in selecting items from measures to be used as indicators.

These findings also link to theoretical models of hallucinations, particularly around whether there can be two or three distinct aspects to hallucinations within the LSHS-R (Aleman et al., 2001; Levitan et al., 1996; Stanghellini et al., 2012; Waters

et al., 2003). For instance, this may link to multi-dimensions of the LSHS-R, mirroring factorial analyses for vivid daydreams and intrusive thoughts as playing a role within hallucinatory experiences that are assessed by the LSHS-R (Larøi et al., 2004). There may need further research to explore potential similarities between clinical and non-clinical populations, and assess whether it is the cognitive misappraisals or misattributions of internal events as mentioned in section 1. that may lead to distress and/or maintenance of hallucinatory experiences.

The ambiguity of some of the results could in part be due to the scope and properties of the LSHS-R. For example, the scale assesses a broad range of hallucinatory experiences including visual, olfactory, tactile experiences), and a broad range of complexity from simple sounds/simple shapes to clearly heard voices/clear solid images. Moving forward there may be a need to develop new measures for assessing specific forms of hallucinatory experiences in across clinical and non-clinical samples (Aynsworth et al., 2017; Ratcliff et al., 2011).

4.1. Study limitations

There were a number of limitations associated with the current study. Full demographic details were missing for a number of participants, which may lead to potential variations or biases within the samples. For instance, this may include respondent bias for the LSHS-R, where individuals may either enhance or diminish ratings for particular items due to fear of stigma (Burke et al., 2016; Wong et al., 2009; Wood et al., 2015) or perceived social desirability (DeVylder & Hilimire, 2015). Another factor may be recruitment bias, particularly if selected from specific university/university courses (potentially not representative of the general population), or may have selected clinical samples who experience mild-moderate distress. However, individuals with severe distressing hallucinatory experiences may

not have been recruited due to the informed consent processes or have been perceived as not appropriate to approach for research.

Moreover, there was significant differences in demographics, particularly age and education, potentially a factor in the interpretation of the LSHS-R questions, alongside potential variations of hallucinatory experiences. However, as each data-set will have recruited in the same way, these biases would be consistent across the whole data-set, therefore sharing similar demographic limitations between the groups.

It seems that the key limitation of this study was the LSHS-R, particularly as the correlations between the indicators was higher than desirable, and correlation coefficients between PANSS and the LSHS-R were notably weak. However, it can be difficult to achieve low correlations between indicators, as the data within this study was not perfect; individual differences, missing data and other factors are likely to impact on data within psychological research. Furthermore, the LSHS-R also has comparatively few items capturing visual hallucinations. A number of difficulties have been highlighted in developing tools to assess visual or tactile hallucinatory experiences (Aynsworth et al., 2017; Bell et al., 2010).

For instance, Aynsworth et al.'s (2017) review identify a lack of reviewing histories of visual hallucinations within current measures, with key limitations for the constructs measured, such as not assessing the full variations within visual hallucinations beyond occurrence and frequency. Bell et al. (2010) also detailed similar limitations, arguing for more detailed assessments of hallucinations beyond concepts of frequency and occurrence. They argued these assessments need to include exploration of the potential triggers, the content of hallucinations and emotional experiences of hallucinations. Therefore current hallucination scales may

be limited; in terms of capturing the dimensional qualities of hallucinatory experiences in both clinical and non-clinical samples. Consequently, these results may only capture continuum for vivid daydreams, intrusive thoughts and auditory clinical hallucinatory experiences; further research may need to develop ways to assess these other experiences within hallucinations.

A further limitation is related to the Cohen's d for this study, which ranged between values of 1.8-2.2. Although this was relatively high in the context of general statistical analyses, this may have limited the study since ≥2.2 is generally recommended for more rigour within taxometric analyses (Ruscio et al., 2013), and two of the three indicators were below this.

4.2. Clinical implications

In terms of clinical implications, the study findings may have important implications for how practitioners, service users and members of the public more broadly understand mental health difficulties. As previously discussed, studies have highlighted how being diagnosed with a mental disorder can be stigmatising (Burke et al., 2016; Wong et al., 2009; Wood et al., 2015). This can lead to secondary maintenance of difficulties due to perceived or actual societal stigma (Baba et al., 2017; Lien et al., 2015; Longdon, & Read, 2017).

Early identification of individuals who may require support for their experiences, may be needed, as their hallucinatory experiences may be overlooked or misunderstood if labelled diagnostically (Baba et al., 2017; Longdon & Read, 2017). Focusing instead on specific experiences that exist on a continuum across the general population may help normalise these experiences, and empower individuals to seek support when these experiences become unmanageable or distressing.

This may also give rise to opportunities to explore specific experiences within psychological therapies, potentially suggesting for therapies to focus on particular experiences such as hallucinations rather than for psychosis. For instance, current therapies such as Cognitive Behavioural Therapy focus on psychosis, though may address hallucinatory experiences. This may also indicate a potential for Research Domain Criteria, where Schmidt (2015) argues for symptom-specific research, rather than fully diagnostic classification based research. This study may indicate that assessments need to acknowledge and capture the breadth of specific experiences like hallucinations, alongside developing therapies to focus on these specific experiences rather than overall labels such as psychosis.

4.3. Future Directions

It may be useful for further research to examine other “symptoms” within psychosis or schizophrenia categories, such as thought disorder and delusions to see if these also lie on a continuum or are categorical. Further research may also examine developing tools to assess other experiences within hallucinations, particularly visual hallucinations and ways to separate these from organic induced visual hallucinations (such as within Parkinson’ Disease, Dementia with Lewy Bodies) and non-organic induced.

Studies may be undertaken to assess other aspects that may contribute to the spectrum of hallucinatory experiences, especially for those scoring highly in non-clinical samples. For instance, there may need to be assessment of potential triggers for hallucinations in non-clinical samples or potential factors (such as culture, spirituality, gender or age) that may play a role (Larøi, et al., 2014; Theodoridou et al., 2016). Other factors to assess may also be narratives around hallucinatory

experiences, family histories and potential trauma, in relation to support seeking and distress levels (Longden et al., 2016).

Consequently, this may enable early identification of those at potential risk of distressing experiences who require further support. Early identification may also reduce the need for future intensive support and escalating distress from hallucinatory experiences, particularly if interventions focus on de-stigmatising the labels of psychosis and hallucinations.

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Appendices

Appendix A: Journal of Social and Clinical Psychology: Information for authors

The Journal of Social and Clinical Psychology is devoted to the application of theory and research from social psychology toward the better understanding of human adaptation and adjustment, including both the alleviation of psychological problems and distress (e.g., psychopathology) and the enhancement of psychological well-being among the psychologically healthy. Topics of interest include (but are not limited to) traditionally defined psychopathology (e.g., depression), common emotional and behavioral problems in living (e.g., conflicts in close relationships), the enhancement of subjective well-being, and the processes of psychological change in everyday life (e.g., self-regulation) and professional settings (e.g., psychotherapy and counseling).

Articles reporting the results of theory-driven empirical research are given priority, but theoretical and review articles are also welcome. Articles describing the development of new scales (personality or otherwise) or the revision of existing scales are not appropriate. All submissions must be made electronically (preferably in Microsoft Word format) to Thomas E. Joiner at joiner@psy.fsu.edu. Only original articles will be considered. Articles should not exceed 8,000 words (text and references). Exceptions may be made for reports of multiple studies. Abstracts should not exceed 200 words. Authors desiring an anonymous review should request this in the submission letter. In such cases identifying information about the authors and their affiliations should appear only on a cover page.

TABLES

Tables should be submitted in Excel. Tables formatted in Microsoft Word's Table function are also acceptable. (Tables should not be submitted using tabs, returns, or spaces as formatting tools.)

FIGURES

Figures must be submitted separately as graphic files (in order of preference: tif, eps, jpg, bmp, gif; note that PowerPoint is not acceptable) in the highest possible resolution. Figure caption text should be included in the article's Microsoft word file. All figures must be in black & white.

PERMISSIONS:

Contributors are responsible for obtaining permission from copyright owners if they use an illustration, table, or lengthy quote (100+ words) that has been published elsewhere. Contributors should write both the publisher and author of such material, requesting nonexclusive world rights in all languages for use in the article and in all future editions of it.

REFERENCES:

Authors should consult the publication manual of the American Psychological Association for rules on format and style. All research papers submitted to the Journal of Social and Clinical Psychology must conform to the ethical standards of the American Psychological Association. Articles should be written in nonsexist

language. Any manuscripts with references that are incorrectly formatted will be returned by the publisher for revision.

Appendix B: Scoping searches/Process notes

Search Strategy 1

(schizophren* or psychosis or psychoses or psychotic disorder or schizotypal or schizotypy or hallucinat* or paranoi* or thought disorder or delusion* or disorganised behaviour or disorganized behaviour or disorganised speech or disorganized speech or negative symptoms or voice hear* or hearing voices or anomalous experiences) AND (Mental imagery or mental images or visuospatial imagery or auditory imagery)

Reflection: Too many terms that are going beyond psychosis experiences, perhaps reason for generating too many results. Need to refine question further. Need to consider other forms of mental imagery that might not be captured, such as vividness of imagery or other mental imagery experiences. Most of papers do not seem relevant

Search Strategy 2

(mental image* OR vivid* image* OR visu* image* OR musical image* OR auditory image* OR creative image*) and (hallucinat* OR "positive symptom*" OR psychosis OR psychotic OR psychoses OR schizophren* OR schizoty* OR paranoi* or "thought disorder" or delusion*)

Reflection: Still too broad, may need to refine psychosis experiences to specific types of experiences such as hallucinations; results have improved since last search but need refining further. However need to be cautious about specificity due to risk of missing out relevant papers that may have other terms for hallucinatory experiences.

Final search strategy

1.mental image* OR vivid* image* OR visu* image* OR musical image* OR auditory image* OR creative image*

AND

2. hallucinat* OR voice hear* OR hear* voices or “positive symptom*”

Table 1: *Example of full search and record of number of result per search term (PsychINFO)*

Word	**Hits**
Mental image*	26,842
Vivid* image*	2,216
Visu* image*	34,472
Musical image*	753
auditory image*	4,263
creative image*	2,291
mental image* OR vivid* image* OR visu* image* OR musical image* OR auditory image* OR creative image*	58,399
hallucinat*	16,155
voice hear*	6,176
hear* voices	6,176
positive symptom*	45,817
mental image* OR vivid* image* OR visu* image* OR musical image* OR auditory image* OR creative image* AND hallucinat* OR voice hear* OR hear* voices or “positive symptom*”	1,146
mental image* OR vivid* image* OR visu* image* OR musical image* OR auditory image* OR creative image* AND hallucinat* OR voice hear* OR hear* voices or “positive symptom*” (English)	1,010

Database search PsycINFO; date searched; May 2018; terms searched article, title, abstract, keyword (any field)

Appendix C: Quality Assessment Tool for Studies with Diverse Designs (QATSDD) instruction sheet (Sirriyeh et al., 2012)

Instruction sheet

You have been provided with:

a) Instruction sheet – this sheet explains how to use the tool.
b) Quality assessment criteria which includes descriptions of what is required to achieve each score.
c) Scoring grid to enable you to record the scores for each paper against the criteria.
d) Evaluation form – this form is to be returned to Reema Sirriyeh, Institute of Psychological Sciences and will be used as part of a broader evaluation of the efficacy and usefulness of this tool.

Eligibility criteria for papers:

1. Original research papers for inclusion into a systematic review
2. Study design must be qualitative, quantitative or mixed methods

Method:

Scoring the studies:

1. Read through the research paper carefully.
2. There are 16 quality criteria in the tool; 14 of these criteria apply to qualitative studies, 14 apply to quantitative studies and all 16 apply to any mixed methods papers. The applicable questions are indicated in brackets in the grid under the item.
3. Read each of the criteria and look at the descriptions under each score from 0-3 to find out what is required to obtain each score.
4. Using the descriptions for each score to guide your response, give the paper a score from 0-3 on each item on your scoring grid.
5. This will result in a score out of a maximum of 48 (16x3) for mixed methods papers, and 42 (14x3) for qualitative or quantitative papers.

Comparing the quality of studies:

1. In order to compare quality of the papers you should calculate what % of the maximum possible score was obtained see example below:

A **quantitative** paper scores 39 out of 42 = 92.9% of the maximum quality score. This could be compared to a **qualitative** paper that scores 9 out of 42 = 21.4% of

maximum quality score, suggesting that the **quantitative** work was of a higher quality.

1. In addition you can calculate a quality score for all studies using the same design as a group e.g. the qualitative studies. This allows comparisons to be drawn for example between the qualitative and quantitative papers.
2. To do this you would take an average of the quality scores calculated for each paper for each group and then compare these.

Appendix D: QATSDD guidelines for scoring (Sirriyeh et al., 2012)

Criteria	0 = Not at all	1 = Very slightly	2 = Moderately	3 = Complete
Explicit theoretical framework (A)	No mention at all.	Reference to broad theoretical basis.	Reference to a specific theoretical basis.	Explicit statement of theoretical framework and/or constructs applied to the research.
Statement of aims/objectives in main body of report (B)	No mention at all.	General reference to aim/objective at some point in the report including abstract.	Reference to broad aims/objectives in main body of report.	Explicit statement of aims/objectives in main body of report.
Clear description of research setting (C)	No mention at all.	General description of research area and background, e.g. 'in primary care'.	General description of research problem in the target population, e.g. 'among GPs in primary care'.	Specific description of the research problem and target population in the context of the study, e.g. nurses and doctors from GP practices in the east midlands.
Evidence of sample size considered in terms of analysis (D)	No mention at all.	Basic explanation for choice of sample size. Evidence that size of the sample has been considered in study design.	Evidence of consideration of sample size in terms of saturation/information redundancy or to fit	Explicit statement of data being gathered until information redundancy/saturation was reached or to fit exact calculations for analytical requirements.

			generic analytical requirements.	
Representative sample of target group of a reasonable size (E)	No statement of target group.	Sample is limited but represents some of the target group or representative but very small.	Sample is somewhat diverse but not entirely representative, e.g. inclusive of all age groups, experience but only one workplace. Requires discussion of target population to determine what sample is required to be representative.	Sample includes individuals to represent a cross section of the target population, considering factors such as experience, age and workplace.
Description of procedure for data collection (F)	No mention at all.	Very basic and brief outline of data collection procedure, e.g. ‘using a questionnaire distributed to staff’.	States each stage of data collection procedure but with limited detail, or states some stages in details but omits others.	Detailed description of each stage of the data collection procedure, including when, where and how data were gathered.
Rationale for choice of data collection tool(s) (G)	No mention at all.	Very limited explanation for choice of data collection tool(s).	Basic explanation of rationale for choice of data collection tool(s),	Detailed explanation of rationale for choice of data collection tool(s), e.g. relevance to the study aims and assessments of tool quality either statistically,

			e.g. based on use in a prior similar study.	e.g. for reliability & validity, or relevant qualitative assessment.
Detailed recruitment data (H)	No mention at all.	Minimal recruitment data, e.g. no. of questionnaire sent and no. returned.	Some recruitment information but not complete account of the recruitment process, e.g. recruitment figures but no information on strategy used.	Complete data regarding no. approached, no. recruited, attrition data where relevant, method of recruitment.
Statistical assessment of reliability and validity of measurement tool(s) (Quantitative only) (I)	No mention at all.	Reliability and validity of measurement tool(s) discussed, but not statistically assessed.	Some attempt to assess reliability and validity of measurement tool(s) but insufficient, e.g. attempt to establish test–retest reliability is unsuccessful but no action is taken.	Suitable and thorough statistical assessment of reliability and validity of measurement tool(s) with reference to the quality of evidence as a result of the measures used.

Fit between stated research question and method of data collection (Quantitative) (J)	No research question stated.	Method of data collection can only address some aspects of the research question.	Method of data collection can address the research question but there is a more suitable alternative that could have been used or used in addition.	Method of data collection selected is the most suitable approach to attempt answer the research question
Fit between stated research question and format and content of data collection tool e.g. interview schedule (Qualitative) (K)	No research question stated.	Structure and/or content only suitable to address the research question in some aspects or superficially.	Structure & content allows for data to be gathered broadly addressing the stated research question(s) but could benefit from greater detail.	Structure & content allows for detailed data to be gathered around all relevant issues required to address the stated research question(s).
Fit between research question and method of analysis (L)	No mention at all.	Method of analysis can only address the research question basically or broadly.	Method of analysis can address the research question but there is a more suitable alternative that could have been used or used in addition to offer greater detail.	Method of analysis selected is the most suitable approach to attempt answer the research question in detail, e.g. for qualitative IPA preferable for experiences vs. content analysis to elicit frequency of occurrence of events, etc.

Good justification for analytical method selected (M)	No mention at all.	Basic explanation for choice of analytical method	Fairly detailed explanation of choice of analytical method.	Detailed explanation for choice of analytical method based on nature of research question(s).
Assessment of reliability of analytical process (Qualitative only) (N)	No mention at all.	More than one researcher involved in the analytical process but no further reliability assessment.	Limited attempt to assess reliability, e.g. reliance on one method.	Use of a range of methods to assess reliability, e.g. triangulation, multiple researchers, varying research backgrounds.
Evidence of user involvement in design (O)	No mention at all.	Use of pilot study but no involvement in planning stages of study design.	Pilot study with feedback from users informing changes to the design.	Explicit consultation with steering group or statement or formal consultation with users in planning of study design.
Strengths and limitations critically discussed (P)	No mention at all.	Very limited mention of strengths and limitations with omissions of many key issues.	Discussion of some of the key strengths and weaknesses of the study but not complete.	Discussion of strengths and limitations of all aspects of study including design, measures, procedure, sample & analysis.

Appendix E: Initial QATSDD results from rater (CF)

Paper	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Total	Total percentage
Aleman, et al (2001) ,	2	3	1	0	1	2	1	0	0	2	NA	2	0	NA	0	2	16	38.10%
Aleman,et al (2000)	2	3	1	0	2	2	1	1	0	2	NA	2	1	NA	0	1	18	42.86%
Aleman, Böcker & de Haan (1999)	3	3	1	0	1	2	1	1	0	2	NA	2	1	NA	0	2	19	45.24%
Aynsworth, et al (2017) (experiment 2)	2	3	1	3	2	2	3	0	2	2	NA	1	1	NA	0	3	25	59.52%
Barrett (1992),(study one)	2	2	2	0	1	3	0	0	0	3	NA	3	3	NA	0	1	20	47.62%
Barrett (1992) (study two)	2	2	2	0	1	3	0	1	0	2	NA	3	3	NA	0	1	20	47.62%
Böcker, et al (2000)	2	2	3	0	3	2	1	2	0	2	NA	2	2	NA	0	2	23	54.76%
Brett & Starker (1977)	3	3	2	0	1	2	2	0	0	1	NA	2	1	NA	0	1	18	42.86%
David & Cutting (1992)	3	3	3	0	2	2	2	2	0	2	NA	2	2	NA	0	1	24	57.14%
Glazer, et al (2013)	3	3	2	0	1	2	2	2	1	2	NA	2	0	NA	0	2	22	52.38%

Heilbrun, et al(1983)	2	2	3	0	1	3	1	1	0	1	NA	1	0	NA	0	1	16	38.10%
Mintz & Alpert, (1972)	2	2	3	0	1	3	0	2	0	1	NA	2	1	NA	0	1	18	42.86%
Oertel, et al (2009)	3	2	3	0	2	1	2	2	3	2	NA	3	2	NA	0	2	27	64.29%
Sack, et al (2005)	2	3	2	0	2	2	3	2	2	2	NA	2	2	NA	0	2	26	61.90%
Starker & Jolin, (1984)	3	2	3	0	1	2	2	2	1	2	NA	2	1	NA	0	1	22	52.38%
van de Ven & Merckelbach (2003)	2	2	2	0	1	2	1	1	2	1	NA	2	2	NA	0	2	20	47.62%

Key

A= Explicit Theoretical Framework
B= Statement of aims/objectives
C=Clear description of research setting
D=Evidence of sample size considered in terms of analysis
E=Representative sample of target group of reasonable size
F=Description of procedure for data collection
G=Rationale for choice of data collection tool(s)
H=Detailed recruitment data
I=Statistical assessment of reliability and validity of measurement tool
J=Fit between stated research question and method of data collection
K=Fit between stated research question and data collection(qualitative only)
L=Fit between research question and method of analysis
M=Good justification for analytical method selected
N= Assessment of reliability of analytical process (qualitative only)
O= Evidence of user involvement in design
P= Strengths and limitations critically discussed

Appendix F: Initial QATSDD results from rater (AE)

Paper	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Total	Total percentage
Aleman, et al (2001) ,	2	3	1	0	1	2	1	0	0	2	NA	2	0	NA	0	2	16	38.10%
Aleman,et al (2000)	2	3	1	0	2	2	0	0	0	2	NA	2	2	NA	0	2	18	42.86%
Aleman, Böcker & de Haan (1999)	3	3	1	0	1	2	0	0	0	2	NA	3	2	NA	0	2	19	45.24%
Aynsworth, et al (2017) (experiment 2)	3	3	1	2	0	2	2	2	2	2	NA	2	2	NA	0	2	25	59.52%
Barrett (1992),(study one)	3	2	2	0	2	1	0	2	1	1	NA	2	2	NA	0	2	20	47.62%
Barrett (1992) (study two)	3	2	2	0	2	2	0	1	0	2	NA	2	2	NA	0	2	20	47.62%
Böcker, et al (2000)	3	3	3	0	0	0	2	0	3	2	NA	2	2	NA	0	3	23	54.76%
Brett & Starker (1977)	3	3	3	0	0	0	0	1	1	1	NA	1	1	NA	0	2	16	38.10%
David & Cutting (1992)	3	2	3	0	2	2	2	2	0	1	NA	2	1	NA	0	2	22	52.38%
Glazer, et al (2013)	2	3	2	0	1	2	2	2	0	2	NA	2	2	NA	0	2	22	52.38%

Heilbrun, et al(1983)	2	1	3	0	1	2	2	2	0	1	NA	1	0	NA	0	1	16	38.10%
Mintz & Alpert, (1972)	2	2	3	0	1	3	0	1	0	1	NA	1	1	NA	0	1	16	38,10%
Oertel, et al (2009)	3	3	3	0	2	0	2	2	2	2	NA	3	2	NA	0	3	27	64.29%
Sack, et al (2005)	3	2	3	0	1	2	2	2	1	1	NA	2	2	NA	0	2	23	52.38%
Starker & Jolin, (1984)	3	2	3	0	1	3	1	2	0	2	NA	2	2	NA	0	2	23	54.76%
van de Ven & Merckelbach (2003)	2	2	1	0	1	2	1	2	2	1	NA	2	2	NA	0	2	20	47.62%

Key

A= Explicit Theoretical Framework
B= Statement of aims/objectives
C=Clear description of research setting
D=Evidence of sample size considered in terms of analysis
E=Representative sample of target group of reasonable size
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K=Fit between stated research question and data collection(qualitative only)
L=Fit between research question and method of analysis
M=Good justification for analytical method selected
N= Assessment of reliability of analytical process (qualitative only)
O= Evidence of user involvement in design
P= Strengths and limitations critically discussed

Appendix G: Schizophrenia Research journal guidelines

Guide for Authors

AIMS AND SCOPE:

Schizophrenia Research provides rapid publication of new international research that contributes to the understanding of schizophrenia and related disorders. The journal brings together previously separated biological, clinical and psychological research on this disorder, and stimulates the synthesis of clinical and research data into cohesive hypothesis.

TYPES OF PAPERS:

(1) Full-length papers: 4000 words (excluding tables, figures and references).(2) Short communications: 1000-1500 words (excluding tables, figures and references).(3) Letters to the Editors: 600-800 words, 10 references, 1 figure or table.(4) Special solicited research and/or reviews.(5) Invited comments or hypotheses.(6) Editorials.(7) Schizophrenia meeting reviews; solicited and/or submitted.(8) Book reviews.

SUBMISSION CHECKLIST:

It is hoped that this list will be useful during the final checking of an article prior to sending it to the journal's editor for review. Please consult this Guide for Authors for further details of any item.

FURTHER CONSIDERATIONS

•Manuscript has been "spell checked"
•References are in the correct format for this journal
•All references mentioned in the Reference list are cited in the text, and vice versa
•Permission has been obtained for use of copyrighted material from other sources (including the Web).
•Colour figures are clearly marked as being intended for colour reproduction or to be reproduced in black-and-white

Preparation of text

PRESENTATION OF MANUSCRIPT

Please write your text in good English (American or British usage is accepted, but not a mixture of these). Italics are not to be used for expressions of Latin origin, for example, in vivo, et al., per se. Use decimal points (not commas); use a space for thousands (10 000 and above).

Provide the following data on the title page (in the order given).

Title. Concise and informative. The title should indicate the main point of the manuscript. Note that titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.

Author names and affiliations. Where the family name may be ambiguous (e.g., a double name), please indicate this clearly. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name, and, if available, the e-mail address of each author.

Corresponding author. Clearly indicate who is willing to handle correspondence at all stages of refereeing and publication, also post-publication. Ensure that telephone and fax numbers (with country and area code) are provided in addition to the e-mail address and the complete postal address.

Present/permanent address. If an author has moved since the work described in the article was done, or was visiting at the time, a 'Present address' (or 'Permanent address') may be indicated as a footnote to that author's name. The address at which the author actually did the work must be retained as the main, affiliation address. Superscript Arabic numerals are used for such footnotes.

Abstract. A concise and factual abstract is required (maximum length 250 words for full-length papers or 100 words for short communications). The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separate from the article, so it must be able to stand alone. References should therefore be avoided, but if essential, they must be cited in full, without reference to the reference list. Non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

Keywords. Immediately after the abstract, provide a maximum of six keywords, using American spelling and avoiding general and plural terms and multiple concepts (avoid, for example, 'and', 'of'). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords will be used for indexing purposes.

Abbreviations. Define abbreviations that are not standard in this field at their first occurrence in the article: in the abstract but also in the main text after it. Ensure consistency of abbreviations throughout the article.

ARRANGEMENT OF THE ARTICLE

Subdivision of the article. Divide your article into clearly defined and numbered sections. Subsections should be numbered 1.1 (then 1.1.1, 1.1.2, 2), 1.2, etc. (the abstract is not included in section numbering). Use this numbering also for internal cross-referencing: do not just refer to 'the text'. Any subsection may be given a brief heading. Each heading should appear on its own separate line.

Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. If these references are included in the reference list they should follow the standard reference style of the journal and should include a substitution of the publication date with either 'Unpublished results' or 'Personal communication'. Citation of a reference as 'in press' implies that the item has been accepted for publication.

Web references
As a minimum, the full URL should be given and the date when the reference was last accessed. Any further information, if known (DOI, author names, dates, reference to a source publication, etc.), should also be given. Web references can be listed separately (e.g., after the reference list) under a different heading if desired, or can be included in the reference list.

Reference management software
This journal has standard templates available in key reference management packages EndNote (http://www.endnote.com/support/enstyles.asp) and Reference Manager (http://refman.com/support/rmstyles.asp). Using plug-ins to wordprocessing packages, authors only need to select the appropriate journal template when preparing their article and the list of references and citations to these will be formatted according to the journal style.

Responsibility for the accuracy of bibliographic citations lies entirely with the authors.

Text: All citations in the text should refer to:

1. *Single author:* the author's name (without initials, unless there is ambiguity) and the year of publication;
2. *Two authors:* both authors' names and the year of publication;
3. *Three or more authors:* first author's name followed by 'et al.' and the year of publication.

Citations may be made directly (or parenthetically). Groups of references should be listed first alphabetically, then chronologically.

Examples: "as demonstrated (Allan, 1996a, 1996b, 1999; Allan and Jones, 1995). Kramer et al. (2000) have recently shown ...."

List: References should be arranged first alphabetically and then further sorted chronologically if necessary. More than one reference from the same author(s) in the same year must be identified by the letters "a", "b", "c", etc., placed after the year of publication.

Examples:

Reference to a journal publication:
Van der Geer, J., Hanraads, J.A.J., Lupton, R.A., 2000. The art of writing a scientific article. J. Sci. Commun. 163 (2) 51-59.

Reference to a book:
Strunk Jr., W., White, E.B., 1979. The Elements of Style, third ed. Macmillan, New York.

Reference to a chapter in an edited book:
Mettam, G.R., Adams, L.B., 1999. How to prepare an electronic version of your article, in: Jones, B.S., Smith, R.Z. (Eds.), Introduction to the Electronic Age. E-Publishing Inc., New York, pp. 281–304.

Journal names should be abbreviated according to the List of serial title word abbreviations: http://www.issn.org/services/online-services/access-to-the-ltwa/

Appendix H: Email correspondence with Ethics

Hi Cheri,

Another very good question! Yes, the University has a research data management policy (https://www.liverpool.ac.uk/library/research-data-management/) which would still apply, even though there is no need for research ethics approval. This policy gives guidance on retention periods and archiving data.

All the best,

Matthew

From: Fletcher, Cheri
Sent: 05 December 2017 08:52
To: Billington, Matthew [mjbill2]
Subject: RE: University ethics query

Thankyou very much for this, I was wondering also do I still need to follow any particular data management policies if ethical approval is not required (i.e. archiving data for 10 years post study?)

With kind regards
Cheri Fletcher
Trainee Clinical Psychologist/3rd year Doctoral student

From: Billington, Matthew [mjbill2]
Sent: 29 November 2017 12:15
To: Fletcher, Cheri
Cc: White, Ross
Subject: RE: University ethics query

Hi Cheri,

This is a good question.

There would be no need for University research ethics approval if the project only involves the secondary analysis of fully anonymised data.

I hope this helps – just let me know if there's anything you need further info on.

All the best,

Matthew Billington

Senior Research Ethics and Integrity Officer

Research Support Office

University of Liverpool

From: Fletcher, Cheri
Sent: 28 November 2017 12:07
To: Billington, Matthew [mjbill2]
Cc: White, Ross
Subject: University ethics query

Hi, I was wondering if you may be able to help or if you may be able to signpost me to who I need to liaise with regarding my query.

I am currently writing a research proposal and was unsure whether ethical approval is required. I will be conducting a secondary data analysis on existing anonymised data sets from clinical and student samples that have been used for other published studies? Will this require university ethical approval or not?

With kind regards
Cheri Fletcher
Trainee Clinical Psychologist

Appendix I: Launay-Slade Hallucinations Scale (Bentall & Slade, 1985)

1. **No matter how hard I try to concentrate, unrelated thoughts always creep into my mind**

□ Certainly applies
□ Possibly applies
□ Unsure
□ Possibly does not apply
□ Certainly does not apply

2. **In my daydreams I can hear the sound of a tune almost as clearly as I was listening to it**

□ Certainly applies
□ Possibly applies
□ Unsure
□ Possibly does not apply
□ Certainly does not apply

3. **Sometimes my thoughts seem as real as actual events in my life**

□ Certainly applies
□ Possibly applies
□ Unsure
□ Possibly does not apply
□ Certainly does not apply

4. **Sometimes a passing thought will seem so real that it frightens me**

□ Certainly applies
□ Possibly applies
□ Unsure

□ Possibly does not apply

□ Certainly does not apply

5. The sounds I hear in my daydreams are usually clear and distinct

□ Certainly applies

□ Possibly applies

□ Unsure

□ Possibly does not apply

□ Certainly does not apply

6. The people in my daydreams seem to true to life that I sometimes think they are

□ Certainly applies

□ Possibly applies

□ Unsure

□ Possibly does not apply

□ Certainly does not apply

7. I often hear a voice speaking my thoughts aloud

□ Certainly applies

□ Possibly applies

□ Unsure

□ Possibly does not apply

□ Certainly does not apply

8. In the past I have had the experience of hearing a person's voice and then found that no one was there

□ Certainly applies

□ Possibly applies

□ Unsure

 Possibly does not apply

 Certainly does not apply

9. On occasions I have seen a person's face in front of me when no one was in fact there

 Certainly applies

 Possibly applies

 Unsure

 Possibly does not apply

 Certainly does not apply

10. I have heard the voice of the devil

 Certainly applies

 Possibly applies

 Unsure

 Possibly does not apply

 Certainly does not apply

11. In the past I have heard the voice of God specking to me

 Certainly applies

 Possibly applies

 Unsure

 Possibly does not apply

 Certainly does not apply

12. I have been troubled by hearing voices in my head

 Certainly applies

 Possibly applies

 Unsure

 Possibly does not apply

 Certainly does not apply